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ANNUAL REPORT OF THE AGRICULTURAL RESEARCH SCHEME FOR THE YEAR 1940-41

GENERAL.

Steady progress towards the solution of manifold agricultural problems was maintained during the year. Broad conclusions that were drawn from the first year's investigations have been corroborated in the second season to which this report refers. As the investigations progressed it became abundantly clear that there is a great deal to be done, and what we do not know about jute greatly exceeds our present knowledge. Hitherto unknown diseases and pests of jute have come to light. Retting is still an unexplored field. Problems that could possibly be taken up in addition to the normal programme of work have been taken on hand. Others await the strengthening of the staff and the facilities at the Jute Research Laboratories.

Members of the staff have given their best. It would help their work to a great extent if suitable quarters are provided for them near the Dacca Farm.

I. COLLECTION OF VARIETIES AND TYPES.

Forty district-samples of seeds were collected and grown in small observational plots. Their composition and possibilities of making selections were investigated. Out of the twenty-one *capsularis* samples, seventeen proved to be mixtures of green and red types, the maximum of the foreign type being 35 per cent. All the nineteen *olitorius* samples were mixtures of green and red plants, but the maximum of the foreign type was as low as 6 per cent.

Five wild species of jute *viz.*, *C. fascicularis*, *C. olitorius*, *C. trilocularis*, *C. tridens*, and *C. antichorus*, were received through the courtesy of the Cotton Specialist, Coimbatore and Economic Botanist, Poona. The last two were received late in the season and could not be sown.

II. SELECTIONS.

The object of plant-breeding work *viz.*, selection and hybridization is to evolve superior and more efficient races of jute. Jutes that are better in quality and out-turn, have higher fibre content and can withstand adverse conditions, diseases, and pests are being sought for. This improvement as has been the experience in most of the crops, is gradual, and is not generally achieved simultaneously in all the directions, it has to be effected step by step.

A. *Criterion for selection.*—

A sound morphological basis for selection is a very necessary adjunct in plant-breeding work. This is particularly so in jute as the selected plant has to be kept for seed and its fibre content cannot be determined. In 1939 season, it was established that height and diameter of the stem were correlated with its fibre content. Work in 1940 was directed to find out whether these correlations hold equally good in other varieties of jute and whether the relationship was appreciably influenced by seasonal conditions.

Height and diameter of stems, and fibre weights were recorded for 360 plants, each of D.154, D.386, Fanduk, Chinsurah Greeen, R.26 and Dacca Local varieties. Total and partial correlations worked out from these data, are furnished in table I. It is clear that the relationship between fibre-yield, height and diameter of the stem, that was observed in 1939 for the variety D.154, also holds good for other *capsularis* and *olitorius* varieties. Height appears to be more important in *olitorius* than in *capsularis*.

TABLE I

Total and partial correlations

(All the correlations are positive and significant)

Variety	Total correlations			Partial correlations	
	r12	r13	r23	r12·3	r13·2
Dacca Local	0·668	0 902	0·556	0·464	0·858
R.26	0·733	0·836	0·638	0·472	0·703
Chinsurah Green	0·713	0·886	0·625	0·440	0·805
Fanduk	0·591	0 879	0·552	0·266	0·822
D·386	0·662	0·916	0·639	0·248	0·855
D·154 (1940)	0·650	0·934	0·647	0·168	0·886
(1939)	0·761	0·914	0·719	0·368	0·813

Note :—1=fibre weight ; 2=height of stem ; 3=diameter of stem at the base.

A novel sight—line sown Jute

Normal

Jute Res. Lab.

Colchicine treated

B. *New Selections.*—

From the varieties Fanduk, D.154, D.386, Chinsurah Green, R.26 and Dacca Local, six hundred and fifty-two selections were made in the field by eye judgement. All these selections were measured for height and diameter of the stem. After rejecting those that did not fulfil the minimum requirements for height and, diameter, two hundred and sixty-four selections were finally retained for trial in a replicated progeny row-test in 1941.

C. *Preliminary trials of selections.*—

(*i*) *First year trial.*—It will be remembered that some 800 selections were made in 1939. Out of these 123+20 *olitorius* selections and 93 *capsularis* selections were tried out in three replicated progeny row tests. The remaining selections were lumped together variety-wise and tried out as mass-selected material.

123 *olitorius* cultures were put in a replicated progeny row test. Individual plant records of base-diameter, plant height and pigmentation were kept on 9,000 odd plants. On the basis of analyses of yield corrected for stand, plant heights, base-diameters, and fibre percentages, the best cultures have been retained for future work.

Twenty *olitorius* early selections were tested. Seventeen cultures proved to be earlier in maturity than the standard Chinsurah Green. Some cultures matured twenty-four days earlier. All the cultures that were apperciably early, yielded significantly less fibre than the standard. Three of these cultures have been added to the collection and the rest of the material has been rejected.

Ninety-three *capsularis* selections made in 1939, were tried out in a replicated progeny row test. Cultures deemed worthy of further work have been carried forward.

The remaining selections of 1939 were lumped together variety-wise and treated as mass-selected material. In a replicated trial these mass-selected bulks did not reveal any superiority in yield. Further selection was carried out from this material.

(*ii*) *Second year trial.*—Out of 108 selections in *capsularis* progeny row tests of 1939, 35 were brought forward to 1940. Of the 11 types in the *capsularis* preliminary yield tests only three were deemed worthy of trial in 1940. These thirty-eight selections were split up into two trials having twenty-four and fourteen selections respectively.

Twenty-four selections together with the standard were tried in a 5 × 5 lattice square, the most convenient layout. The results are presented in table II. It may be noticed that twenty-one cultures proved significantly better yielders than D.154.

Fourteen other *capsularis* cultures were tested in a randomized replicated trial. Analyses furnished in table III show that none of these cultures are superior to D.154 either in yield, fibre percentage, or height, and they need not be carried forward.

TABLE II.

Capsularis second year test.

Object.—To compare the yield performance of D. 154 and the selections coming from 1939 progeny row test.

Layout.—3 replications of 5 × 5 lattice squares; effective size of each plot = 1/606 acres; sown in Mastul on 11-5-40; harvested on 27-9-40 excepting marked *on 8-9-40.

Varieties.	Fibre yield in lb. per acre.	Percentage yield on control.	Percentage of fibre to green weight.	Mean height of plant in feet.
F. D. Water—272 ...	1405·9	183·9	5·40	6·8
D. 27 × D. 154—284 ...	1362·7	178·2	5·15	6·1
D. 154 × Variant (N)—264 ...	1341·6	175·5	5·38	6·6
K. B. Sgi	1323·2	173·1	5·29	6·3
D. 154. U. F. 2·12—270 ...	1293·9	169·2	4·81	6·7
39 × ?—215	1276·9	167·0	4·79	6·3
D. 27 × D. 154—244 ...	1217·6	159·3	4·92	5·8
Normal × D. 154—248 ...	1213·1	158·7	4·26	5 8
D. 154 × Variant (N)—193 ...	1147·8	150·1	4·67	6·3

TABLE II.—*Contd.*

Varieties	Fibre yield in lb. per acre.	Percentage yield on control.	Percentage of fibre to green weight.	Mean height of plant in feet.
D. 27 × D. 154—245 ...	1142·1	149·3	5·40	6·1
D. 154 × D. 27—267 ...	1127·3	147·5	5·10	6·4
39 × ? × G.O,—254 ...	1109·3	145·1	5 14	6·5
D. 154 × Variant (N)—192 ...	1074-8	140·6	5·52	5·8
39 × ?—214 ...	1008·5	131·9	4·81	6·4
Normal VN ^{12}—140 ...	992·7	129·8	4·51	5·7
D. 154 U. F. 2·12—225 ...	988·8	129·3	4·81	5·9
39 × ?—307	964·6	126·2	5·04	6·3
D. 136 × R. 85—305 ...	939·9	122·9	4·50	6·9
39 × ? × G.O.—277 ...	932·2	121·9	5·20	5·8
39 × ? × G.O.—255 ...	932·1	121·9	5·06	6·5
D. 154 U.F. 2·12—271 ...	861·4	112·7	4·85	6·6
D. 136—296* ...	858·2	112·3	4·33	5·5
D. 154 (standard) ...	764·5	100·0	4·54	5·7
39 × ? × G.O.—269 ...	707·9	92·6	4·24	6·5
D. 136—220*	458·1	59·9	3·84	5·2
P ...	0·01	—	Large	Large
S. E.% ...	3·6	—	7·1	6·7
Sig. diff. ...	113·6	—	—	—

TABLE III.

Capsularis selections second year test.

Object.—To compare some 1939 promising strains against the standard D.154.

Layout.—Randomized blocks in 6 replications, effective size of plots = 1/212 acres. Sown on 13-5-40. Harvested Megnal Satnal and Fuleswari on 8-9-40, rest on 25-9-40.

Varieties	Fibre yield in lb. per acre	Percentage yield on control	Percentage of fibre to green weight	Mean height per plant in feet
D. 154	1106	100·0	6·40	6·13
Dhal × R. 85	1085	98·2	6·56	5·86
J. C. 1	1050	94·9	6·30	5·98
R. 85 × D. 136	1011	91·4	6·25	5·72
D. 154 × Variant ...	1007	91·0	6·10	6·15
Barapat	1007	91·0	5·81	6·47
Normal × D. 154 ...	1004	90·7	6·50	6·22
Jap. × R. 85	989	89·4	6·35	5·90
Barapat × D. 154 ...	982	88·8	6·24	5·95
Megnal Satnal ...	968	87·5	5·43	5·75
39 × ? × G. O.	883	79·8	6·51	5·79
D. 154 × Dhal	862	77·9	6·06	5·58
Sutpat	855	77·3	5·75	5·72
Fuleswari	784	70·8	5·42	5·18
P	0·01	...	0·01	0·05
S. E. %	2·5	...	2·00	3·7
Sig. Diff. ...	227	...	0·325	0·61

Three *olitorius* selections *viz.*, R.26 × G.O., G.O. Aksir, and G.O. × Lalpat were to be tested for the second time in 1940. The quantity of seed available for the last two selections was, however, very small and therefore the entire seed was used in seed multiplication plots. R.26 × G.O. was found to be composed of two types, green and red. These types were separated and

numbered as MS.7 and MS.8 respectively. These two were tried out along with Chinsurah Green. Though MS.7 yielded 12 per cent. more than the control, the difference did not prove satistically significant, vide table IV.

TABLE IV

Olitorius selections test second year

Object.—To compare the strains against Chinsurah Green.

Layout.—Randomized blocks in 6 replications; effective size of plots =1/250 acres. Sown on 14-5-40; harvested on 30-9-40.

——	C. G.	M. S. 7	M. S. 8	P	S. E.%	Sig. diff.
Fibre yield lb. per acre	1723	1932	1895	Large	3·8	...
Percentage yield on control	100·0	112·1	109·9	...	...	...
Percentage of fibre to green weight ...	6·24	7·01	6·61	Large	5·9	...
Mean height of plant in feet	8·17	8·86	8·95	0·01	1·5	0·59

III. HYBRIDIZATION.

A. *Varietal.*—

With the object of improving Chinsurah Green in respect of earliness, and D.154 in respect of earliness and yield, the following crosses were made in 1939.

D.154 × Cross early

Fanduk × Cross early

(C.G. × R.26) selection × R.26

(C.G. × R.26) selection × C. G.

Seeds from crossed pods were grown in 1940, and 246 F_1 plants were raised and studied for their height, base-diameter, date of flowering, and incidence of chlorosis.

B. *Interspecific.*—

Seeds obtained through attempted crossing of *capsularis* and *olitorius* species in 1939, were sown, but very few seeds germinated and all the resultant plants resembled female parent and were evidently accidental selfs.

During the year under report fresh attempts were made to cross the two species. Attempts were also made to hybridize the two cultivated species with the wild ones. On examination, the crossed seeds mostly appear to be very light and shrivelled.

IV. INHERITANCE OF CHARACTERS.

A. *Chlorosis.*—

Certain chlorotic and non-chlorotic plants were kept under observation throughout the season. Their progenies will be grown in the coming season and it will be watched whether non-chlorotic progenies become chlorotic and vice-versa.

Detailed diagrammatic records of development and progress of chlorosis were kept on twenty-six *capsularis* plants. This study was further supplemented by weekly observational notes on forty-eight *capsularis* plants. The earliest attack of chlorosis was found to start within fifteen days of sowing, *i.e.*, when the plants had three to four leaves. Chlorosis first appeared to start as a small bright yellow patch on leaf surface. As the leaf increased in size, the yellow patches also increased in size and number, and could be noticed on both the leaf surfaces. Big yellow patches ultimately broke up into small specks of less intense colour, and were distributed throughout the lamina of the leaf. The surface of the leaf became rough and crinkled.

When the disease first appears, only two or three leaves at the top shows chlorosis, but within three or four days it spreads to all the top leaves. Thereafter, the disease gradually travels downdards and out-wards, attacking first, young leaves, and then the mature leaves. New leaves at the top are infected as they appear.

Partial recovery was noticed in some plants, but definite instances of complete recovery were rare. Plants, attacked at a very early stage remained stunted and weak, while those that were slightly affected or were attacked later, did not appear to suffer at all and reached their normal height.

In a few mature *olitorius* plants, chlorosis was observed at Dacca as well as in the districts. The chlorotic patches were brighter than those of *capsularis*. Chlorosis was, however, very rare in *olitorius*.

Attempts were made to transfer chlorosis from the diseased to healthy plants. The disease could not be transmitted by smearing juice of diseased leaves on to healthy ones. Chlorotic buds were budded on to normal plants, but budding did not succeed. Out of seventy-one successful grafts between non-chlorotic *capsularis* and chlorotic *capsularis*, in forty-eight cases chlorosis could be transferred to the graft.

B. *Length of fibre.*—

F_1 s were grown and studied.

C. *Variant.*—

F_1 plants were raised and classified as below.—

Cross	Normal	Variants
D. 154 × Variant	23	0
Normal × Variant	1	0
Variant × Normal	2	0
Variant × Variant	0	2

D. *Colour.*—

Basing on the extent and intensity of the red anthocyanin pigment in the plant, seven grades were established for *capsularis* varieties. Grade O corresponds to pure green plants and grade six to fully red plants. Crosses were made involving all the grades barring the grade four. Back crosses were also made.

Pigmentation studies of individual progenies, in the progeny row-tests have revealed that Finlow's observation that normally jute was self-fertilized applies only to *capsularis* and that in *olitorius* there is considerable natural cross-pollination.

In the *olitorius* replicated-progeny-row-test there were fifty red and seventy-three green single-plant cultures. Of the fifty red families twenty-two bred true, twelve gave one to three green plants per family which may be regarded as accidental mixtures. The remaining sixteen families proved heterozygous segregating in the ratio of 3 red : 1 green.

	Red	Green	Total
Observed ...	1079	365	1444
Expected on 3 : 1 ...	1083	361	1444

Of the seventy-three green families only four were pure green. Twenty-two green families had one to three red plants, which may be accidentals. In progenies of forty-seven green families, red plants varied from four to twenty-four. In these forty-seven families there were in all 4849 plants of which 414 were reds, giving 8·5 per cent. natural crossing.

From among the ninety-three cultures in the *capsularis* progeny-row-test, sixty-eight bred ture, one family segregated giving 3 : 1 ratio; and in the remaining twenty-four families there were only twenty-five off-type doubtful plants out of a total of 1946 plants. In no culture were there more than four off-type plants and it was quite possible that they might be accidentals. Even if it is assumed that all these off-type doubtful plants were natural crosses, the percentage of natural crossing amounts to 1·3 per cent.

In view of the important bearing of the mode of natural pollination on breeding technique, suitable material has been carried forward to test the origin of some of these off-type plants.

E. *Shape of pod.*—

In the variety Deodhali, the shape of the pod is oval and in D.154 it is round. The pods of F_1s of Deodhali × D.154 cross were intermediate in shape, the base of the pod being not so elongated as in Deodhali.

F. *Leaf-shape.*—

In jute unlike in many other crops, there are only a few morphological characters on the basis of which a variety of jute can be identified. Distribution and intensity of red colour in the plant is practically the only morphological character available for this purpose. Oval shape of the pod is confined only to Fuleswari and Deodhali varieties, both being *capsularis*. A preliminary investigation suggested the possibility of utilizing the leaf shape for this purpose. Leaf index $\frac{\text{(length of the blade)}}{\text{(breadth of the blade)}}$ was calculated by measuring three mature leaves at the top of each plant. In each variety, leaves of 360 plants were measured and it was found that Fanduk had significantly narrower leaves than either D.154 or D.386. Similarly, Dacca Local had

significantly narrower leaves than either Chinsurah Green or R.26. The following leaf indices were recorded.

Fanduk—2·22 > D.386 – 1·94 = D.154 – 1·92 ; C.D. = 0·05
Local —2·38 > R.26 – 2·31 = C.G. – 2·30 ; C.D. = 0·06.

G. *Base-diameter.*—

In view of the important correlations that were obtained between base-diameter and fibre-yield, thin and thick-stemmed selections have been made for studying the inheritance of this character.

H. *Fibre-percentage.*—

Apart from base-diameter and height of the plant, the third component of yield is fibre-percentage. As a matter of routine, fibre-percentage is being determined for all the varieties and cultures that appear in various yield tests. Certain cultures which have relatively a high fibre content have been carried forward with a view to ascertain whether this character is inherited. The variability in fibre content is less than that of the production of green matter.

Culture No.	Yield of fibre as percentage on control.	Fibre percentage as per percentage on control.
D. 154 ...	100 0	100·0
15 ...	158·7	93·8
1 ...	159·3	108·4
6 ...	167 0	105·5
17 ...	169·2	105·9
25 ...	173·1	116·5
14 ...	175·5	118·5
3 ...	178·2	113·4
23 ...	183·9	118·9

V. QUALITY OF JUTE.

A. *Effect of varieties, growth conditions, and different kinds of retting waters on the quality.*—

Three varieties of jute were grown at various stations in randomized plots with twelve replications. Part of the green produce of each plot, sampled at random, was sent to Dacca for retting. The remaining material was retted at the respective stations. Samples of fibre were sent to our Technological Laboratories for tests.

Results of technological tests on 1939 quality trials have been received from the Director, Technological Laboratories. Important technological data, as well as primary data regarding the growth and retting conditions are appended in Enclosure II. For chemical analyses of retting waters references may be made to the annual report for 1939-40. Pending the collection of at least one more year's data it appears that the quality of fibre largely depends upon the conditions of growth of the jute plant, as well as conditions under which it is retted. Though the influence of variety of jute on quality seems on first consideration to be small, we must not loose sight of the fact that our experience has been limited to only three varieties where the differences between the varieties are small and they get masked by the larger environmental factors. Inspite of this, with good conditions of growth and retting, a better variety gives superior fibre. To bring out the varietal differences, contrasting varieties should be taken up and to locate such varieties, a wider examination is necessary. Examination of a number of varieties will quite possibly reveal the primary importance of varietal differences and it may be found that no amount of soil and retting conditions will make up for inherent poor quality of a variety.

(*a*) *Capsularis*.—Varieties D.154, D.386, and Fanduk were grown at Dacca, Rangpur and Faridpur farms. The results presented in table V are in conformity with those of 1939 experiments. The variety Fanduk yielded again significantly less than either D.154 or D.386. This was due to its shorter height and lower fibre-percentage.

(*b*) *Olitorius*.—Varieties Chinsurah Green, R.26 and the respective locals were grown at Dacca, Chinsurah, Pabna and Berhampore. From the results presented in table VI it will be seen that in general the variety Chinsurah Green has proved to be the best in yield.

TABLE V.

Quality trials (Capsularis).

Object.—1. To compare the yield of strains.

2. To study the effect of varieties, growth conditions, different kinds of retting water and duration of retting on quality.

Layout.—Randomized blocks in 12 replications.

	Varieties.			P	S.E.%	C.D.	Conclusion.	Remarks.
	A D. 154	B D. 386	C Fanduk					
Dacca.								
1. Stand at harvest per acre ...	136416	129686	142100	0·01	1·6	8692	C A B	Effective plot size = 1/49 acre.
2. Green weight in lb. per acre ...	32221	30603	25426	0·01	1·3	1565	A B C	Sown East Suti field on 29-3-40.
3. Fibre yield in lb. per acre ...	1621	1659	1212	0·01	1·3	55	BA C	Harvested.—D. 154—11-9-4 .
4. Percentage yield on control ...	100	102·3	74·2	...	...	...	...	D. 386—15-9-40.
5. Percentage fibre to green wt.	6·3	6·6	6·0	0·01	1·2	0·2	B A C	Fanduk—21-8-40.
6. Mean height per plant in feet...	8·0	8·4	7·1	0·01	2·5	0·8	BA C	
Rangpur.								
1. Stand at harvest per acre ...	56706	65603	83073	0·01	7·9	15807	C BA	Effective plot size = 1/76 acre.
2. Green weight in lb. per acre ...	16429	22432	21512	Large	9·0	...	B C A	Sown on 10-4-40.
3. Fibre yield in lb. per acre ...	1376	1444	1116	0·05	5·2	199·6	BA C	Harvested.—D. 154—18-9-40.
4. Percentage yield on control ...	100	104·9	81·1	...	...	...	...	D. 386—23-9-40.
5. Percentage fibre to green wt.	7·6	6·7	6·5	0·01	2·1	0·6	A BC	Fanduk— 6-9-40.
6. Mean height per plant in feet...	9·49	9·61	8·56	0·01	2·4	0·89	BA C	
Faridpur.								
1. Stand at harvest per acre ...	51539	48459	53850	Large	5·7	...	C A B	Effective plot size = 1/50 acre.
2. Green weight in lb. per acre ...	27865	26550	27556	Large	2·8	...	A B C	Sown on 22-4-40.
3. Fibre yield in lb. per acre ...	1385	1512	1030	0 01	4·2	220	BA C	Harvested —D. 154—27-9-40 & 28-9-40.
4. Percentage yield on control ...	100	109·2	74·4	...	...	...	...	D. 386—20-9-40.
5. Percentage fibre to green wt.	5·0	5·7	3·8	0·01	5·7	0·8	BA C	Fanduk—26-8-40 & 27-8-40.
6. Mean height per plant in feet...	7·6	7·4	7·4	Large	1·8	...	A B C	

TABLE VI.

Quality trials (Olitorius).

——	Varieties. A C. G.	B R. 26	C Local	P	S.E.%	C.D.	Conclusion.	Remarks.
DACCA.								
1. Stand at harvest per acre ...	98115	96677	93885	Large	2·2	...	A B C	Effective plot size=1/49 acre.
2. Green weight in lb. per acre ...	23380	21750	20457	0·01	2·6	2306	A BC	Sown East Suti field on 18-5-40.
3. Fibre yield in lb. per acre ...	1226	1018	1082	0·01	2·5	80·0	A CB	Harvested.—C.G.—27-9-40.
4. Percentage yield on control ...	100	83·0	88·2	...	...	...	...	R. 26—2-10-40.
5. Percentage of fibre to green wt.	5·4	5·4	4·9	0·01	1·0	0·2	AB C	Local—27-9-40.
6. Mean height per plant in feet...	8·5	8·6	8·1	0·01	1·0	0·3	BA C	
CHINSURAH.								
1. Stand at harvest per acre ...	145719	150512	144631	Large	2·3	...	B A C	Effective plot size=1/69 acre.
2. Green weight in lb. per acre ...	43575	44255	43216	Large	2·3	...	B A C	Sown on 22-5-40.
3. Fibre yield in lb. per acre ...	2305·2	2182·5	2152·4	0·01	1·0	62	A BC	Harvested.—C.G.—30-9-40.
4. Percentage yield on control ...	100	94·7	93·4	...	...	...	...	R. 26—2-10-40.
5. Percentage of fibre to green wt.	5·3	5·0	5 0	Large	1·3	...	A C B	Local—1-10-40.
6. Mean height per plant in feet...	11·9	12·5	11·9	0·01	0·6	0·3	B AC	
BERHAMPORE.								
1. Stand at harvest per acre ...	160613	160613	138329	0·01	2·1	13518	AB C	Effective plot size=1/58 acre.
2. Green weight in lb. per acre ...	26471	24642	24099	0·05	2·1	1526	A BC	Sown on 22-5-40.
3. Fibre yield in lb. per acre ...	1879	1701	1570	0·01	2·2	108	A B C	Harvested.—C.G.—13-9-40 & 14-9-40.
4. Percentage yield on control ...	100	90·5	83·5	...	...	...	...	R.26—14-9-40.
5. Percentage of fibre to green wt.	7·1	6·9	6·7	0·05	1·4	0·3	A BC	Local—15-9-40.
6. Mean height per plant in feet...	10·6	9·7	9·7	0·01	1·0	0·4	A BC	
PABNA.								
1. Stand at harvest per acre ...	130528	128461	127994	Large	1·0	...	A B C	Effective plot size=1/84 acre
2. Green weight in lb. per acre ...	37909	36308	36976	Large	3·7	...	A C B	Sown on 27-4-40.
3. Fibre yield in lb. per acre ...	2403	2379	2323	Large	1·8	...	A B C	Harvested.—C.G.—21-9-40.
4. Percentage yield on control ...	100	99·0	96·7	...	...	...	...	R.26—7-10-40.
5. Percentage of fibre to green wt.	6·54	6·51	5·95	0·01	2·1	0·54	BA C	Local—21-9-40.
6. Mean height per plant in feet...	10·7	10·5	9·9	0·05	1·8	0·5	AB C	

C.G.=Chinsurah Green.

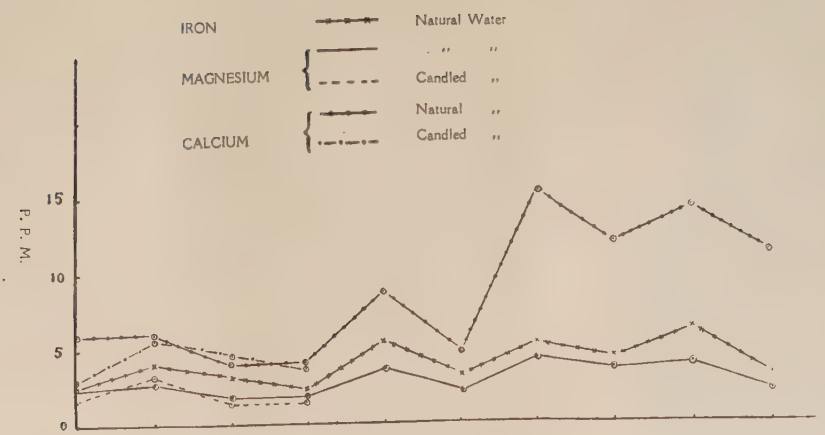

FIG. 1.

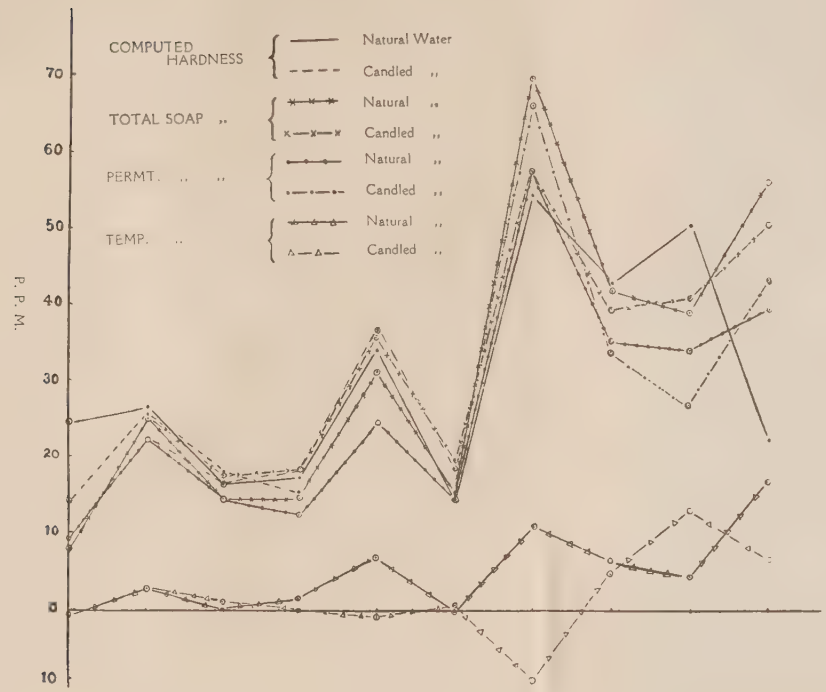

FIG. 2.

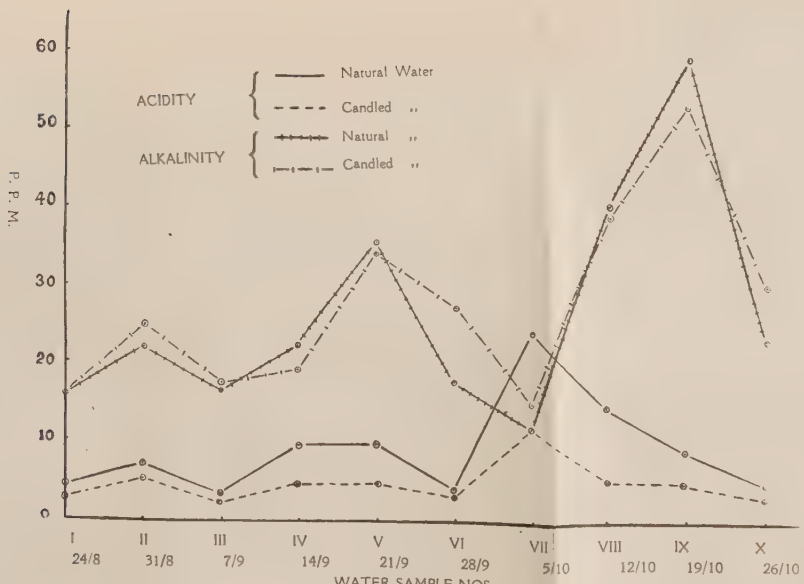

FIG. 3.

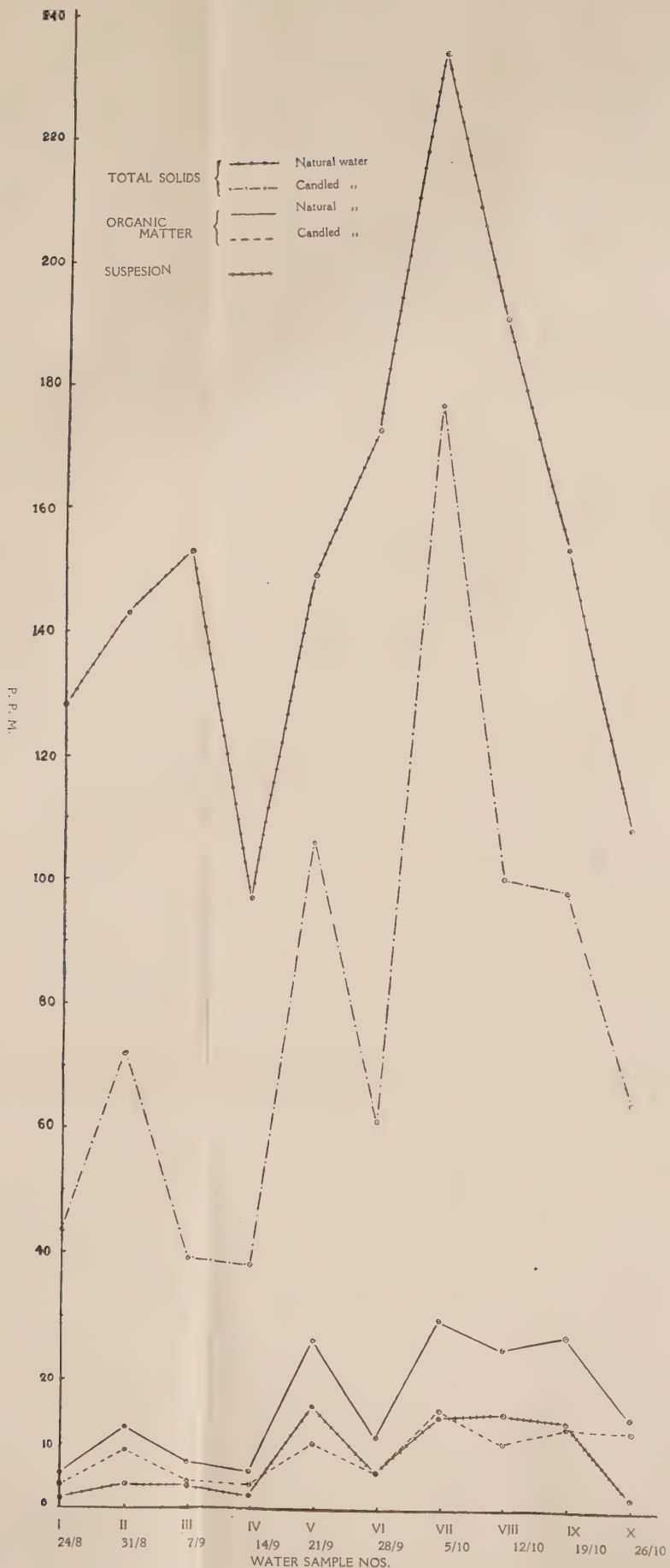
240
220
200
180
160
140
120
100
80
60
40
20
10
0
P. P. M.
TOTAL SOLIDS
Natural water
Candled ,,
ORGANIC MATTER
Natural ,,
Candled ,,
SUSPESION
I 24/8
II 31/8
III 7/9
IV 14/9
V 21/9
VI 28/9
VII 5/10
VIII 12/10
IX 19/10
X 26/10
WATER SAMPLE NOS.

FIG. 4.

B. *Study of retting conditions.*—

(*i*) *Analyses of retting waters.*—Calcium figures in the last year's analyses were in some cases erratic. It was therefore thought that from varying amounts of suspension of clay and fine silt which pass through ordinary filter papers, certain substances might have become soluble during the course of analytical work. To eliminate this possibility all the twenty-eight samples were filtered through a pasteur candle and such filtrate which was termed 'candled water' was analysed. A part of the water from the same sample was filtered through a double-cloth filter and the filtrate which may be termed 'natural water,' was also analysed. Natural and candled waters were analysed for acidity, alkalinity, and total, permanent and temporary soap hardnesses, iron, calcium, magnesium, potassium contents as well as for total solids.

Calcium and magnesium contents of natural and candled samples are parallel and candling has not appreciably modified the readings for these two elements (fig. 1). Computed and soap hardness values are slightly reduced on account of candling (fig. 2). The iron which is present in a colloidal state is, however, eliminated from most of the candled samples. As expected, total solids are much less in the candled waters (fig. 4), than those of the natural waters.

In Dacca samples, it has been observed that when the acidity is maximum, total and permanent soap hardnesses, total solids and organic matter are also at their maximum (figs. 1 to 4). A similar trend has also been noticed in Faridpur samples. These increases are brought about possibly by the solvent action on suspensions of increased acidity produced during retting. Regarding the origin of these suspensions, it would appear that in addition to those originally present in the water, others came from the steeped jute.

During retting the total hardness increases irrespective of the nature of the waters, but the increase in soft waters is mainly due to permanent hardness, whereas it is due to temporary hardness in hard waters like those of Faridpur, vide Enclosure I.

From the results of analytical work it appears that it would suffice if iron, total, permanent and temporary soap hardness, acidity, alkalinity, total solids and possibly organic matter are only estimated.

Nine samples of waters collected from various places in the districts of Dacca and Mymensingh, were excepting for the iron content, similar in composition to the waters from Dacca and Rangpur farms *vide* Enclosure I. This entire group consisted of soft waters having low temporary hardness, and a small amount of total solids and organic matter. Waters from Berhampore and Chinsurah were intermediate in hardness; and Pabna and Faridpur farm waters were the hardest. In the absence of analyses of more of the Western and Northern Bengal samples, it would be premature to suggest that the retting waters of Gangetic deltas in Bengal are hard and those of Brahmaputra deltas are soft.

(ii) Causes of colouration of fibre.—Fibres of 1939 quality experiments were graded by eye judgment according to the colour.

In general Dacca retted fibre, irrespective of the place where it was grown, was darker in colour. Dacca water had distinctly much more of iron than other waters. Further investigations revealed that tannic acid in combination with iron produced colour. Artificial steepings of already prepared fibre in synthetic solutions of known strength of tannic acid and iron were carried out. It has been found that fibre steeped in tannic acid solution, became coloured on re-steeping in iron solution. Reverse process did not produce appreciable colouration. The presence of tannins in the leaves, bark and stem of jute plants was also ascertained analytically. Some varietal differences in tannin contents of the jute varieties have also been noticed.

It appears that water-soluble tannin which is present in jute, gets mordanted wih the cellulosic matter. When these mordanted fibres come in contact with soluble iron they become more or less coloured depending upon the concentrations of iron in the retting water and mordanted tannin.

Of the materials used for weighing down jute, Banana stem contains a large amount of tannin as shown by the following analyses.

		Tannin per cent on oven dry basis.
Mangifera indica (Mango)	Bark ...	6·24
	Stem ...	0·26
Aegle marmelos (Bel)	Bark ...	0·36
	Stem ...	—
Banana whole stem *Musa sp.*	...	17,27

C. *Formation of bark or roots.*—

Gross examination of Dowrah and Chandpur 'rooty' samples of jute revealed that the fibres were heavily coated with 'bark', especially in the lower region. Over 50 per cent. of the length of the fibre was 'barky'. In the lower region *i.e.*, towards the root end, the 'bark' was continuous while in the upper region it was discontinuous. Adventitious roots were frequent in the lower region.

After embedding the fibre in Necoloidine under pressure, sections were cut, stained and examined. The disintegration of the tissues surrounding the fibre was not complete and these could still be distinguished (Plate IV., Fig. 2). The periderm along with the true cortical parenchyma region was often intact. Fibre bundles alternated with thin-walled phloem cells. Phloem rays in the radial direction remained mostly intact. Funnel-shaped wider rays were distinct. Depressions in the wider rays, and ridges in the fibre region, made the outer surface heavily corrugated (Plate IV., Fig. 9). It is clear that the fibre was extracted from stems which had not retted completely.

D. *Formation of the fibre.*—

The study of the formation and development of fibre was further continued during the year. The stage at which the first fibre is laid in the plant was ascertained. Secondary growth upon which the entire fibre production depends, commences at a very early stage. Fibre is formed as soon as the insertion of the foliar leaves starts. With the continued cambial activity, fibre production is maintained until the plant enters into the reproductive phase when it dwindles, and the cambium shrinks. Ultimately the fibre formation is completely checked. Plants which were retained in the field for a month after the normal harvest-stage, did not reveal appreciable additions to the fibre layers in the stem. In D.154 no new fibre-layers were laid down and in Chinsurah Green only one incomplete layer was added.

Progressive development and distribution of fibre-layers in D.154 and Chinsurah Green are shown in table VII.

TABLE VII.

Progressive development and distribution of fibre layers in D. 154 and C. G.

Days after sowing	Number of fibre layers at various stages of growth and levels of the stem									
Height of the stem above ground level	21 days		53 days		83 days		112 days		124 days (Harvest)	
	D. 154	C. G.	D. 154	C. G.	D. 154	C. G.	D. 154	C. G.	D. 154	C. G.
¾	...	...	1	1	1-2	2-3	2-3	3-4	2-3	3-4
Middle	...	...	2-3	2-3	4-5	4-5	5-6	5-6	5-6	5-6
8″	...	...	3-4	3-4	9-10	7-8	10-12	8-10	11-13	8-11
Bottom	1-2	1-2	7-8	6-7	14-15	10-12	15-16	11-13	17-18	12-13

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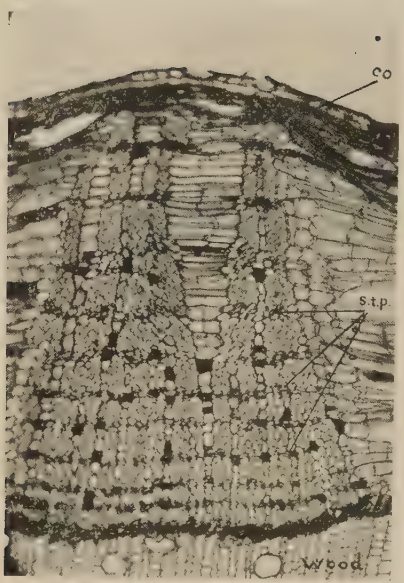

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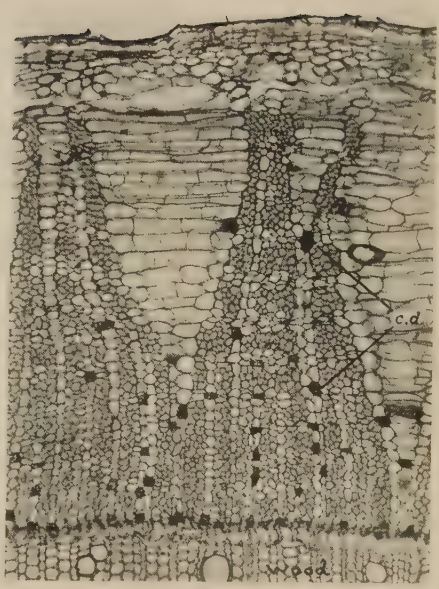

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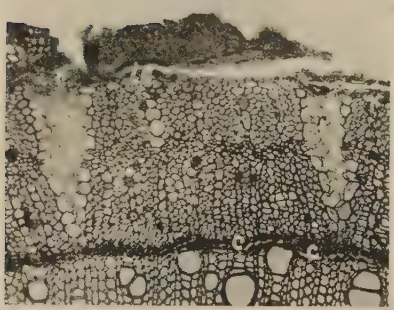

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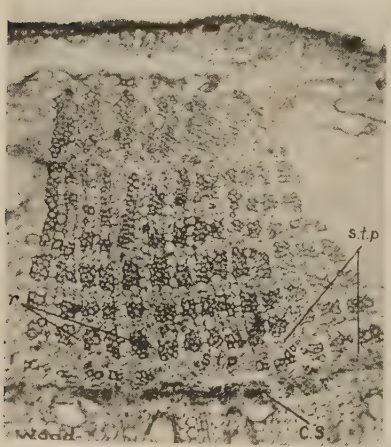

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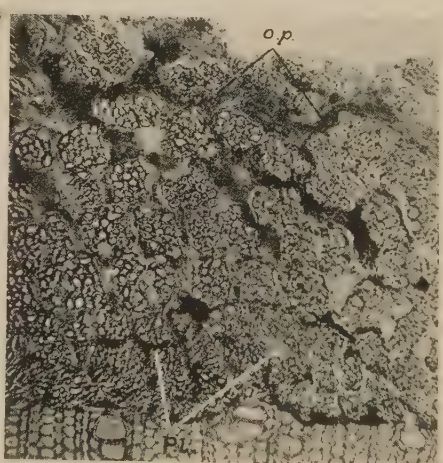

EXPLANATION OF PLATE II.

(All are transverse sections).

Fig. 1.—Section of lower stem showing shrinkage of various tissues 72 hours after harvesting. Entire cortex (co) is flattened, sieve tubes and phloem parenchyma cells (s. t. p.) radially pressed into concentric lines; gum and other deposits common. (×60)

Fig. 2.—Section of lower stem after steeping showing the general swelling up of tissues. Cells are turgid, cell contents dissolved, a few tanniniferous deposits (c.d.) persist. (×60)

Fig. 3.—Section of stem at three-quarter level and retted for 2 days. Cambium (c) disintegrating; part of rays (r) and inner cortex (i.c.) collapsed. (×60)

Fig. 4.—Same as above but showing the condition on the 4th day. Cambium (c) completely dissolved; breakdown of rays (r), and phloem (s. t. p.) well advanced. (×60)

Fig. 5.—Section through middle stem showing the progress of retting after 4 days. Cabium structureless (c.s.); innermost phloem cells (s. t. p.), rays (r) disintegrated; dark deposits completely dissolved. Note that retting starts from innerside of the bark. (×60)

Fig. 6.—Same as above but showing the state of tissues after 6 days. Major part of the rays (r), phloem layers (p.l) dissolved while the outer portions (o.p.) in an advanced stage of retting. (×110).

E. *Anatomy of the retted stem.*—

With the object of gaining complete knowledge regarding the structural changes that take place during retting of jute stems, microscopic examination of retted specimens was carried out. Representative material of stems of Fanduk-variety, collected immediately after harvest, prior to steeping and daily during the course (twenty days) of retting was suitably prepared for anatomical studies. Special technique for embedding the specimens had to be adapted. Handling of the water-soaked stems required considerable skill and patience. Although a number of stains were tried it was difficult to get uniformly good results. For study and observations Gaumann's formula—lacto-phenol and cotton-blue-Safranin, and Stoughton's stain-Thionin and Orange G.—were helpful. The examination was thorough and covered cross as well as longitudinal sections of stem at various levels. The study was supplemented by occasional examination of thin strips of bark in *situ*. The following is a brief account of the changes that occur during retting.

Shrinkage and collapse of pith which result from the stacking of cut-jute in the field facilitate the entry of water into the stem on steeping. The soft tissue of the bark swell and become saturated with water, thus creating a suitable medium for the growth and easy passage of micro-organisms into the stem, besides dissolving out the water-soluble contents of the cells. Forty-eight hours after steeping, growth of the micro-flora within the stem is clearly visible. Two distinct types of bacteria (Plate IV., Figs. 7, 8), and a fungus were observed within the sections. Both the fungus and the bacteria could be noticed in all the tissues barring the fibre bundles and periderm. The organisms enter mostly through the cut ends and to a less extent through the stomatal openings. First of all they were noticed in early xylem vessels, which were often plugged with bacteria and fungus. Continuous growth of the fungus made it easier to trace the course of its invasion; but in the case of bacteria as they spread out quickly it was difficult to follow their exact course. The fungus travels up the stem through the xylem vessels and enters the wood-rays and spreads out radially towards the bark. Once established within the bark it grows profusely and is very conspicuous in wider rays (Plate III., Fig. 2). Then it enters

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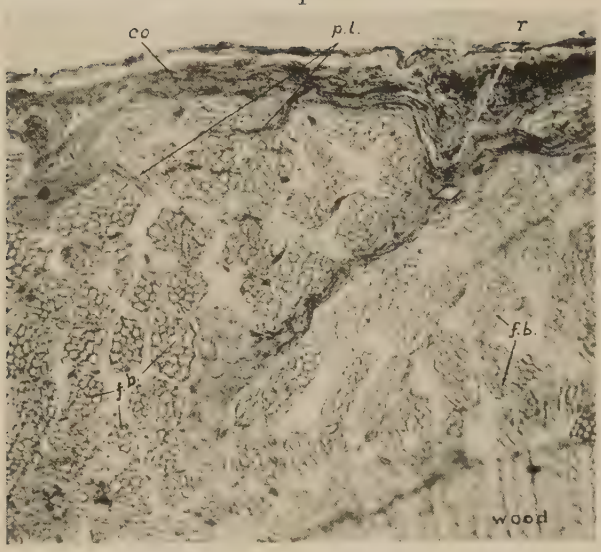

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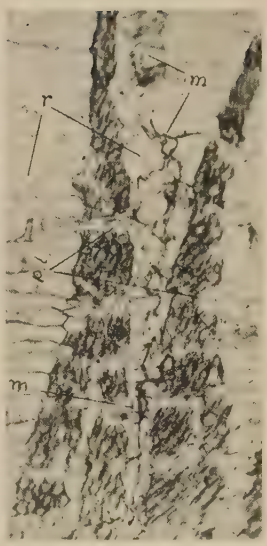

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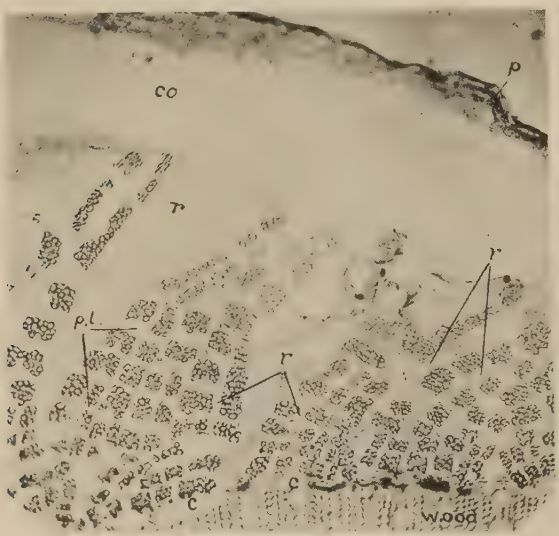

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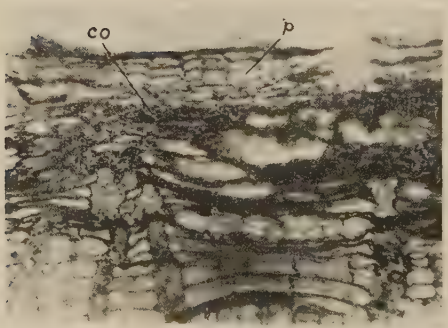

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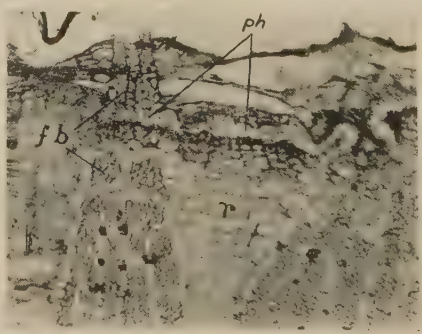

EXPLANATION OF PLATE III.

(All are transverse sections except otherwise mentioned).

Fig. 1.—Section of lower stem showing progress of retting after 11 days. Note that sequence is from inside to outside. Tissues around fibre bundles (f.b.) on the inner side dissolved; while outwards, phloem layers (p.l.), cortex (co), wider rays (r) are still in an early stage of disintegration. (×110).

Fig. 2.—Part of a section showing the growth of mycelium (m) within the rays (r) and phloem layers (p.l). (×110).

Fig. 3.—Section from basal region showing progress of retting after 15 days. Cabium (c) dissolved separating the bark from the wood. Dissolution of phloem layers (p.l), rays (r), cortex (co), but broken tissues still linger within wider rays; periderm (p) isolated. (×50).

Fig. 4.—Same as above but longitudinal section showing the fibre strands (f.s). Note partly dissolved tissues (t) still adhering to the fibre. (×40).

Fig. 5.—Part section showing thick periderm (p) and dark gummy cortex (co) which interfere with retting. (×110).

Fig. 6.—Part section showing development of phellogen (ph) within a ray (r) and extending both sides between the fibre bundles (f.b.) holding them firmly. (×60).

the thin-walled phloem cells and finally into the cortical region. With the disappearance of tissues, fungal hyphae appear to break up and are difficult to locate.

The presence of bacteria in the stem could be noticed earlier than that of the fungus. The first visible signs of bacterial attack are the flattening of cells and breaking down of their radial walls (Plate III., Fig. 1). As a result of the break-down at the points of attack, the continuity of cell-walls is lost, and finally particles of broken cells are observed often in a slimy mass (Plate II., Fig. 6). These broken masses disappear quickly in the top portions of the stem while lower down they linger and even adhere to the fibre strands, necessitating a thorough washing of the fibres (Plate III., Figs. 3, 4).

Retting in jute may therefore be described as a process by which fibre strands contained within the bark are separated out from the hard woody cylinder of the plant, as well as freed in *toto* from other structural elements associated with them (Plate IV., Figs. 1, 3, 6). The sequence of gradual disorganization and disintegration of various cell-structures is as follows:—

1. Zone of cambium.
2. Thin walled phloem ray cells, nearest to cambium.
3. Thin walled phloem cells, such as sieve tubes, and parenchyma nearest to cambium.
4. Thin walled phloem layers and ray cells further outwards.
5. Inner cortical cells nearest to fibres.
6. Outermost soft phloem layers.
7. Outermost cells of 'V' shaped rays.
8. Cells of outer cortex (thereby separating periderm from the cortex all round the stem).

TABLE VIII.

Summary of structural changes within the plant during retting

When examined.	¾ height of the plant.	Mid-region.	8 inch level	Remark.
After harvest.	Epidermis, cortex, thickwalled fibres and thin walled phloem cells arranged alternately, rays, cambium, xylem. Dark deposits in rays.	Same as before. Dark deposits in rays conspicuous.	Periderm added below epidermis, cortex irregular with heavy deposits. Phloem—pyramid shaped.	The cells are in turgid condition.
After 72 hours.	Structure same but shrinkage evident. Stem outline irregular, cortical cells bent. Mucilage, gum ooze out in the cortex.	Shrinkage more marked. Stem outline with ridges and grooves. Cortical cells bent and pressed into narrow wavy layer. Entire cortex dark and gummy, often sunk into wider rays.	Shrinkage well marked. Stem contour with high peaks and depressions. Periderm along with cortex flattened. Thin walled phloem cells pressed into a narrow concentric layer. Deposits abundant.	Except the fibres most of the cells show shrinkage in some form.
One day after steeping.	No change except part swelling of cells.	No change except partial swelling.	No change, shrinkage still prominent.	
3 days after steeping.	Epidermis removed when cortex partly broken, thin phloem cells disorganised, tangential walls of ray cells dissolved, cambium structureless.	Cambium partly broken, innermost thin phloem cells, rays locally dissolved. No other change.	No change. Swelling of tissues in progress.	Growth of microflora.
5 days after steeping.	Except the fibre bundles no other structure is distinguishable.	Epidermis delicate, partly removed, cortex partly broken down, thin phloem layers collapse, general breakdown of rays begins, cambium dissolved mostly.	No change except further swelling. Cambium locally broken, thin phloem cells collapse here and there.	Retting nearly complete in top.
7 days after steeping.	Only fibre bundles remain.	Epidermis, cortex mostly lost. Structureless mass between the fibre bundles, cambium region opened up.	Cell dissolution in progress but topography well maintained, cambium crumbled. Thin phloem cells and rays nearby disintegrating, retting still localised.	

TABLE VIII.—*Contd.*

When examined.	¾ height of the plant.	Mid-region.	8 inch level.	Remark.
9 days after steeping.	Only fibre bundles remain.	Fibre bundles isolated, all tissues dissolved except the nodal region.	Cell dissolution progress in thin phloem and ray cells. Fibre bundles next to cambium isolated. Retting localised.	Retting nearly complete in mid-region.
11 days after steeping.	do.	Fibre bundles isolated.	Cambium structureless, cortex partly disorganised. Cell dissolution of further phloem layers proceeds.	
13 days after steeping.	do.	do.	Cambium zone opening up, part of cortex and phloem dissolved, some of the inner fibre bundles isolated, periderm intact.	
15 days after steeping.	Some fibre bundles tend to separate.	do.	Periderm persists but rupture where inner tissue dissolved. Cortex persists at places, shape of the phloem obliterated due to disintegration of rays and thin phloem layers.	
17 days after steeping.	do.	do.	Periderm isolating, cortex dissolved except at places, rest of the tissues dissolved all round.	
19 days after steeping.	do.	do.	Periderm removed, all tissues dissolved completely, fibre bundles isolated.	Retting complete in the plant.

Anatomical changes that occur after harvest and upto the removal of steeped jute may be divided into five phases, *viz.*—(1) Shrinkage—a pre-steeping phase, (2) swelling and degumming, (3) dissolution of cambium, (4) dissolution of soft phloem cells and (5) dissolution of cortex. The last four are the retting phases and from the table IX it will be noticed that in point of time they overlap.

Before they are steeped, the harvested plants are normally stacked in the field for two to four days. During this period tissues in general shrink, shrinkage being most marked in the basal region of the stem. Consequently the cortical cells, sieve tubes, and the cells of the phloem parenchyma become flattened, stretched or distorted. Epidermis, periderm and ray cells do not suffer the same degree of shrinkage (Plate II., Fig. 1).

Immediately after steeping, the cortical and thin-walled phloem cells commence to swell. This swelling is not uniform in the basal region. Almost concurrently degumming sets in. Mucilage, gums, crystals, other deposits in the cortical region, and tanniniferous contents of ray cells are washed out (Plate II., Fig. 2).

Dissolution of the cambium into structureless slimy masses effects the separation of bark from the woody cylinder. Soon after the cambium is attacked, breakdown of the sieve tubes and parenchyma cells of phloem rays proceeds gradually from inside to outside (Plate II., Fig. 5) till all the soft phloem cells are completely dissolved. In the basal region, disintigration is at first localised and then it gradually spreads.

Dissolution of the cortex particularly of the outer region takes place during the final stages of retting. Cortical cells in the region between the first fibre layer and periderm break-down. With this isolation of the periderm (Plate III, Fig. 3), the retting is complete. Durations of these phases as observed in the top, middle and bottom portions of the stem are furnished below.

TABLE IX.

Durations of phases of retting.

Phase	Top stem	Middle stem	Bottom stem
PRE-STEEPING	Days	Days	Days
1. Shrinkage	1—3	1—3	1— 3
POST-STEEPING			
2. Swelling and degumming ...	1—3	1—5	2—10
3. Dissolution of cambium ...	2—4	3—5	5—12
4. Dissolution of soft phloem cells ...	2—5	3—7	7—17
5. Dissolution of cortex	3—5	5—9	11—19

Five to six days after steeping all the four phases of retting may be seen in one and the same stem at various levels. On account of the presence of (*a*) intercellular spaces, (*b*) gaps caused by the collapse of parenchyma cells in the inner region of the cortex, (*c*) smaller width of the bark with correspondingly less of the non-fibrous tissues, and (*d*) the presence of comparatively thin-walled soft phloem cells, the top portion of the stem rets very much more quickly than the bottom (Plate II., Figs. 3, 4), vide table IX. In the base of the stem the cells of the periderm layer are rectangular and also regular in arrangement. They, therefore, fit in such a way that no inter-cellular spaces are formed. Periderm which is always present in this region forms somewhat of a hard external covering, possibly retarding the rate of swelling and degumming (Plate III., Fig. 5). In the lower stem, the area of the bark is greater and ray parenchyma that has to be dissolved proportionately bigger. In basal region of thicker stems, large masses of cells lying between the outer extremities of the phloem pyramids, form hard tissues which take longer time to be distintegrated. Thick stems consequently take longer to ret completely.

By the time the basal end of the stem can ret, the top portion becomes over-retted, so the fibre bundles at the top get split into smaller ones. This is brought about by the dissolution of the middle lamella in some places.

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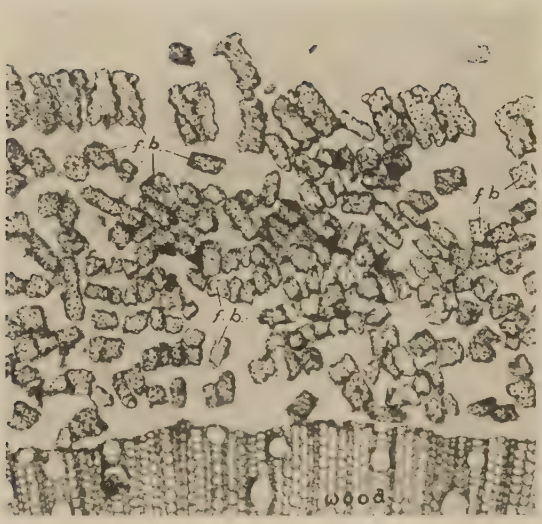

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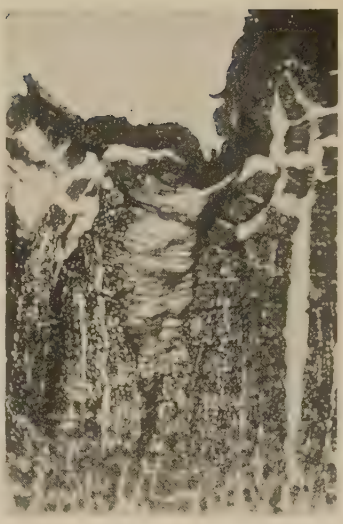

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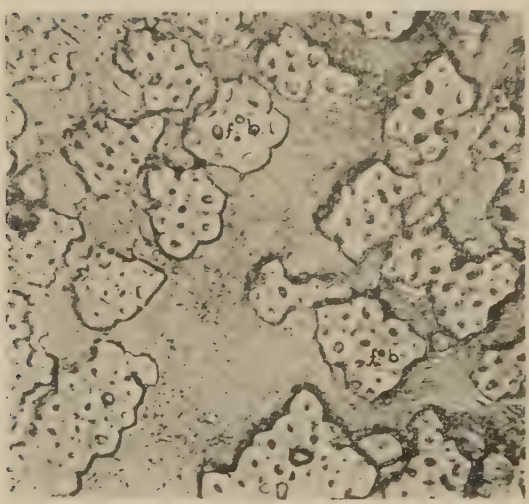

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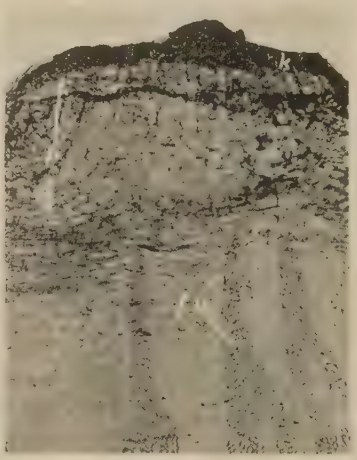

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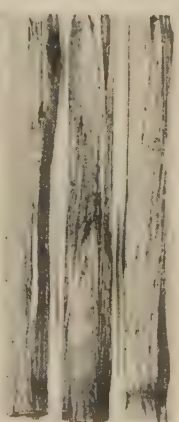

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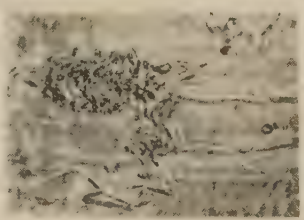

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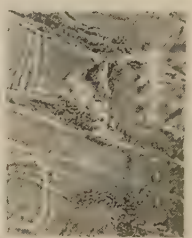

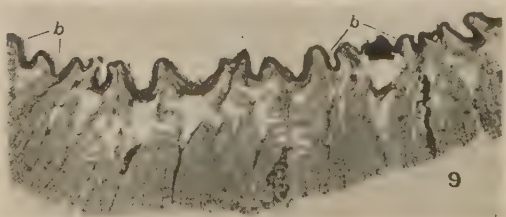

9

EXPLANATION OF PLATE IV.

(All are transverse sections except otherwise mentioned).

Fig. 1.—Section through a completely retted specimen. Note the disappearance of all tissues of the bark except the fibres. Also note that fibre bundles (f.b) have come closer and are arranged on the wood without any connection. (×60).

Fig. 2.—Section through Chandpur fibre specimen. Note the presence of various cell structures indicating that fibre was extracted after the dissolution of only cambium and innermost phloem. (×35).

Fig. 3.—Part section showing micro-organisms round the fibre bundles (f.b). Note that some bundles are isolated while a few are still held together. (×450).

Fig. 4.—Part section through a lenticel showing a compact mass of periderm (*p*) upto the fibres (f.b); outer portion is corky (*k*); retting is greatly delayed in such portions. (×50).

Fig. 5.—Samples showing that internodes (i.n) are retted while tissues in the nodal (*n*) region persist.

Fig. 6.—Completely retted specimen.

Fig. 7.—Bacterial colony within a cell. (×900).

Fig. 8.—Bacterial masses on both the radial and tangential cell walls. (×300).

Fig. 9.—Section through Chandpur fibre sample showing the nature of the attachment of the 'bark' (*b*) to the fibre. (×10).

From the foregoing it is clear that retting is complete in different parts of the same stem at different times, and that the variability in thickness of the stems also contributes to the unevenness of retting. It is apparent that in jute of uniform thickness, the end point of the ret will be reached in all the stems almost simultaneously, whereas all the stems cannot be ready for removal at one time when the steeped jute consists of thick as well as thin stems. The result would either be under or over retting of some of the stems, and the judgment regarding the correct stage for removal would be more difficult.

"Barky' fibre of commerce results from the adherance of patches of thick periderm to the fibre. Periderm is least affected by micro-organisms, and it remains intact for long. The thickness of periderm is not uniform; on some portions of the stem a thick layer of periderm is laid down (Plate III., Fig. 5). Cortical cells underlying this thick layer form a compact mass bordering the fibres. In the region near the lenticels, phellogen activity is greater and consequently a thick periderm is formed. In this region corky cells and suberization are common, and the entire mass forms a hard structural unit (Plate IV., Fig. 4). Similarly in the nodal regions, due to the presence of tracheal tissues of leaf traces retting is delayed (Plate IV., Fig. 5). Portions affected by insects and in some cases by fungus offer great resistance to retting. This is due to the presence of protective and repairing tissues which resist retting. In extreme cases of injury phellogen develops even in between fibre layers, holding (binding) firmly the separated fibre bundles (Plate III., Fig. 6). Thus at the regions near the lenticles, nodes, and places of injury, the fibre is clothed with unretted tissues.

VI. CULTIVATION.

A. *Line sowing.*—

To study the suitability of cultivating jute in lines, a trial was conducted with Chinsurah Green and D.154. Inspite of two resowings, uniform stand could not be obtained. *Olitorius* stood up better in line sowing than *Capsularis*. The former was vigorous, reached a good height and branching was not very marked. Amongst the spacings between the rows, 18″ and 24″ spacings did not appear as promising as 12″ spacing. Till a

uniform stand can be secured, line sowings hold out little hope. Weeding with wheeled hand-hoes is definitely very economical and this is only possible in a line-sown crop.

B. *Spacing and manurial experiment in seed jute.*—

As in the last year, these experiments were run at Pusa and Sabour in Bihar. Chinsurah Green was sown at Pusa and D.154 at Sabour.

At Pusa, the response of various spacing-treatments is very similar to that of the last year. A spacing of 6″ × 15″ has again out-yielded the broadcast plot, but the difference is not significant. Wider spacings between the rows *i.e.*, 24″ and 30″ again have not proved to be so effective as 15″. The response to manurial treatment has rather been unexpected the double dose of fertilizer giving less out-turn than no manure or the single dose.

At Sabour, broadcast sowing proved to be the best. Differences between various spacing-treatments were no significant, but in general closer spacings of 15″ between the rows were more efficient than wider sowings. Application of the single dose of manure gave significantly greater out-turn of seed than the double dose.

TABLE X.

Summary of results of seed jute experiments

Pusa		Sabour	
Spacing	Total yield (gm)	Spacing	Total yield (gm)
6″ × 15″	18455	Broadcast	46138
Broadcast	17265	12″ × 15″	30821
6″ × 24″	15479	6″ × 15″	27637
18″ × 15″	14402	18″ × 15″	27467
12″ × 15″	13636	6″ × 30″	23040
6″ × 30″	13239	12″ × 24″	22700
12″ × 30″	12247	18″ × 24″	22246
12″ × 24″	12048	6″ × 24″	21111
18″ × 24″	11255	12″ × 30″	19747
18″ × 30″	10234	18″ × 30″	19011
Sig. diff.	2359	Sig. diff.	12201

MANURES—

No manure ...	50178	125 lb. Niciphos II per acre	92616
125 lb. Niciphos II per acre	46622	No manure ...	87281
250 lb. Niciphos II per acre	43460	250 lb. Niciphos II per acre	80017
Sig. diff.	2983	Sig. diff.	9818
Manure × Spacing interaction Significant at 5 per cent.		Manure × Spacing interaction not significant.	

C. *Seed-rate and harvest stage experiment.*—

A trial to study the influence of seed-rate and harvest stage on yield and quality was conducted at Dacca. The germination was not good in the first instance and the experiment had to be resown, but the growth and the stand were not still very satisfactory. Plots harvested at bud or flower stage yielded more than those harvested at the pod stage, but the differences were not significant. By the time the crop reached the pod stage, plants died out more and more due to diseases. In general, with a heavier seed-rate, the yield was better.

TABLE XI.

Seed rate, harvest stage and retting period of jute

Object :—Yield and quality of jute to be studied in relation to the seed-rate, stages at which jute is to be harvested and the duration of retting period.

Layout :—Randomized blocks in 6 replications. Effective size of plot = 1/65 acre. Sown in Mastul on 13-5-40. Harvested on 22-8-40 (bud stage), 6-9-40 (flower stage) and 30-9-40 (pod stage).

Treatments	Fibre yield lb. per acre	Percentage of fibre to green weight	Mean height of plants in feet
1. 4″×4″ bud stage ...	1049	5·52	5·27
2. 4″×4″ flower stage ...	1035	5·50	5·99
3. 4″×4″ pod stage ...	785	4·95	5·50
4. 6″×6″ bud stage ...	731	5·58	5·29
5. 6″×6″ flower stage ...	642	5·17	5·59
6. 6″×6″ pod stage ...	498	4·45	5·48
7. 9″×9″ bud stage ...	332	5·07	4·37
8. 9″×9″ flower stage ...	408	4·87	5·77
9. 9″×9″ pod stage ...	339	4·10	5·01
P	0·01	0·01	0 01
S. E.%	8·90	2·78	4·87
Sig. diff.	292	0·399	0·995

VII. DISEASES.

A. *Stem-rot caused by Macrophomina phaseoli.*—

(*i*) *Field investigations.*—To study the progress of disease fifty plants, one month old, with different symptoms were kept under observation. Leaf infection was noticed to have started from the margin and apex of the leaf. Progressing through the mid-rib, it spread to the petiole and finally to the nodal region of the stem. With the increase in spread of leaf infection, those of the stem were also enhanced. Under favourable weather conditions leaves having marginal necrotic lesions, were over-run with the disease within three to four days. Rapid spread of leaf infections was observed to occur between 18th to 24th June.

Wherever a diseased leaf persisted, a discoloured patch appeared at the point of contact. The size of a single lesion varied from a speck to a length of 2 to 2½ inches. As a result of coalescence of lesions, long discoloured streaks are formed along the stem. With age, these streaks produce shredding of epidermis and cuticle. Adventitious roots are formed along the ends of such diseased streaks.

Heavy rainfall commencing with the third week in June favoured the spread of disease. A number of plants died during the second half of June. Field counts of diseased plants taken at monthly intervals indicated that the peak of disease was reached in August-September. Incidence of stem-rot varied from field to field. This may be due to varying soil conditions and dates of sowing. As in the last year, incidence of stem-rot was ascertained in all the important experiments. The data are presented in table XII below.

TABLE XII.

Extent of Stem-rot and Chlorosis

Varieties	Mean per cent stem-rot	Mean per cent chlorosis
Capsularies quality trial (East Suti)—		
D·154	13·9	14·7
D·386	14·4	14·6
Fanduk	16·0	13·2
	not significant	not significant
Olitorius quality trial (East Suti)		
Local	10·9	—
Chinsurah Green	12·4	—
R·26	11·2	—
Capsularies variety test second stage (East Suti)—	not significant	
Barapat × D·154	18·5	19·3
D·154 × D·386	18·9	27·8
D·154 × Variant	19·3	19·0
Barapat	22·1	35·1
D·154	23·1	22·1
Fuleshwari	24·9	19·8
Normal × D·154	25·8	24·5
Jap × R·85	26·9	21·1
Dhaleshwar × R·85	28·9	11·5
D·101 × Dhaleshwar	29·1	17·3
Sutpat	29·8	27·8
Megnal Satnal	30·1	21·9
R·85 × D·386	35·6	20·8
39 × ? × G. O.	38·4	13·5
Critical difference	8·5	8·5
Mass selections (Mastul)—		
Chinsurah Green Selection	17·9	—
Chinsurah Green Standard	21·1	—
Dacca Local selection	23·8	—
Fanduk selection	24·1	21·3
R·26 selection	24·5	—
D.386 selection	29·8	19·5
D.154 standard	32·5	14·9
D.154 selection	42·8	18·8
Critical difference	12·6	2·8

On the whole, 1940 jute season recorded much more of stem-rot than 1939 season. This is true also of most of the jute growing areas in Eastern Bengal. Numerous broken stems could be seen almost everywhere. Highland jute showed more disease than the low-land crop. In Narsingdi and Haimara areas in Dacca district, a very severe and wide-spread out-break of disease popularly known as 'Kaitara' was noticed in August. Symptoms were different from those described so far. Along the stem a number of 'Cankers' are formed and they coalesce. Epidermal tissue cracks and infected plants break off at the infected portion. Ten to fifty per cent of the plants were damaged in this manner. The disease was first noticed by the cultivators about three to four years ago and inspite of the care they took in growing and thinning the crop, it had spread over a considerable area. It was commonly expressed that jute was foresaking the land. All the infected portions of jute, on isolation yielded a culture similar to that usually obtained from typical stem-rot. Peculiarly enough, no sclerotial or pycnidial bodies could be located on infected plants.

(*ii*) *Resistance of different varieties.*—In resisting the stem-rot disease, none of the varieties mentioned in table XII are really superior to the standard ones. A similar conclusion was also drawn from the crop of the 1939 season. In 1940, the entire collection of forty-nine varieties was studied for their resistence to stem-rot and chlorosis. No variety proved to be immune to stem-rot. The degree of suceptibility or resistance seemed to vary from month to month. This point requires further investigation. On the whole it appears that if resistant selections are to be obtained they may be expected from *capsularis* types like D.154 × D.27, Kalichar, and Barapat Rd. U. F. 2·06. In *olitorius*, R.26 may similarly prove to be a useful parental stock. Types like Magnal Satnal, D.154 × Jap. Rd., D.136, Dhaleswar, Fuleswari, Barapat × Magnal, D.101, D.101 × Dhaleswari Rangamati wild, and Simulkandi are not considered suitable parents for deriving a resistant strain.

Comparative resistance of *olitorius* varieties as against *capsularis* types appears to be due to the slow progress of *Macrophomina* in the leaf. Before the leaf is completely affected, it drops off and thus the stem escapes the infection. The lesions on the stem also develop slowly and coalescene of the lesions is scarce.

B. *The Study of the Fungus.*—

(*i*) *Pathogenicity.*—The pathogenicity of the fungus isolated from the stem-rot was again established by different inoculation methods. By dipping the roots of the healthy seedlings 20 days old, in a suspension of *Macrophomina* culture, and then transplanting them in sterilized soil, typical symptoms of 'damping off' were produced. Two days after treatment, the plants showed discolourations at the collar region and subsequently they died producing a number of pycnidial bodies all over the rotten portion. While the controls remained normal, 85 per cent. of the treated plants died. A culture akin to the original was recovered from the infected plants. Similar treatment to plants $2\frac{1}{2}$ months old, however, failed to produce any infection, indicating that with age, the roots resisted the infection.

Plants, one month old when transplanted to infected soil, produced root-rots. In repeated experiments, however, a constant percentage of mortality could not be established.

Corchorus acutangularis was inoculated with a culture of *Macrophomina* after wounding the branches. Although the infection took place, the symptoms did not spread.

(*ii*) *Seed borne infection.*—To disinfect the seed by destroying the fungus borne on and within it, experiments with hot-water treatment of seed were continued. Even when seeds were submerged in water, air tenaciously adhered to the seeds and it became difficult to heat all the seeds to the same extent. Air was therefore evacuated by using a suction pump for twenty minutes. The seeds were thus automatically soaked for twenty minutes. Thereafter, they were subjected to varying temperatures. The duration of the heat-treatment was also varied, *vide* table XIII. All the treated seeds were plated on Potato-dextrose-agar media and incubated at 32°C.

The results, in general, indicate that with higher temperatures, shorter treatments and with lower temperatures longer treatments are necessary. Taking eighty per cent. germination as satisfactory hot-water treatment of seed either at 58°C for seven minutes, 57° for ten minutes or 56° for twenty minutes will prove satisfactory. With these treatments, infection is reasonably reduced. To achieve complete disinfection of seed, germination will have be sacrificed considerably.

TABLE XIII.

Hot-water treatments of seed.

G.P. = Germination percentage.

D.P. = Disease percentage.

Treatment Degrees centigrade.	Duration.	Experiment I.		Experiment II.		Experiment III.		Experiment IV.	
		G. P.	D. P.	G. P.	D. P.	G. P.	D. P.	G. P.	D. P.
55	10	86·4	5·5	...	...	...	...	...	...
55	20	89·6	4·3	89·7	3·6	...	...	...	...
55	25	...	...	81·2	1·9	91·3	1·9	...	...
55	30	91·0	3·2	65·6	0·7	87·8	1·9	...	...
55	40	78·9	1·4	...	...	68·5	0·4	...	...
56	10	88·8	3·7	92·2	6·2	...	...	75·9	1·5
56	15	...	...	83·0	2·4	...	...	76·9	1·1
56	17	...	...	...	...	84·3	4·9	79·2	0·0
56	20	84·1	3·5	79·1	1·1	...	...	80·5	0·0
56	30	69·8	1·0	...	...	...	...	...	...
56	40	46·4	0·0	...	...	...	...	...	...
57	10	93·8	4·3	81·0	2·1	83·4	4·9	89·1	0·7
57	15	...	...	84·6	1·1	...	...	78·4	0·4
57	17	...	...	...	...	...	...	78·1	1·1
57	20	83·4	1·4	63·7	0·3	...	...	65·9	0·4
57	30	63·5	0·4	...	...	...	...	...	...
57	40	28·2	...	...	...	...	...	...	...
58	5	...	...	87·0	4·0	...	...	...	...
58	7	...	...	...	...	82·1	3·7	80·8	1·1
58	10	...	...	54·6	0·0	...	...	...	...
Control	...	89·4	23·7	91·5	22·9	95·1	25·1	94·6	22·7
Critical difference	...	12·3	3·2	10·7	3·8	11·2	4·3	9·4	2·6

N.B.—Blanks in the table indicate that the treatment was not in that particular experiment under reference.

Evacuation of air under water pump was found very cumbersome and several substances were tried for driving away air bubbles. Addition of two drops of 10% Castile soap, in 10 c.c. of water was found to be very effective. With mild shaking all air bubbles were found to escape. Subsequently, this method was used for determining the thermal death-rate of seeds. In this method the pre-soaking of seeds for twenty minutes can be avoided and the seeds can therefore withstand treatments at higher temperatures for short durations. The duration of treatment was fifteen minutes with a temperature range of 30° to 70°C. The viability of seeds was not appreciably affected till 57°C. There was, however, a very marked fall in germination beyond 63°. A gradual decline in the disease was noticed from 40°C onwards, but 0·3 per cent. of the seeds retained the disease even at 70°C while 5 per cent of the seeds proved diseased at 63°C.

C. *Chlorosis.*—

The extent of chlorosis was recorded in all the important experiments, vide table XII. Types D.386 × R.85, and D.154 × D.27 recorded the least chlorosis. The latter also appears to be resistant to *Macrophomina*. Maximum chlorosis was observed in July and August. As in the last season, application of N increased the percentage of chlorosis vide table XIV.

D. *Effect of manures on the incidence of disease.*—

Sixteen treatments with N, P, K and Ca and its combinations were tried, over a basal dressing of cattle manure. Application of N was found to enhance the out-turn of fibre, the best response was obtained when nitrogen was applied in combination with potash and lime. The height and the thickness of the stem were also influenced by fertilizers. As in the last year, NCa plots recorded maximum fibre percentage. Applications of potash alone or in combination with lime or phosphate tended to check the infection of stem-rot. The results again indicate that chlorosis does not affect the yield appreciably, but the stem-rot does. For the best yielding treatment—NKCa—the percentage of chlorosis was the highest and stem-rot the least. Minimum outturn of fibre was obtained from the treatment having maximum stem-rot and minimum of chlorosis.

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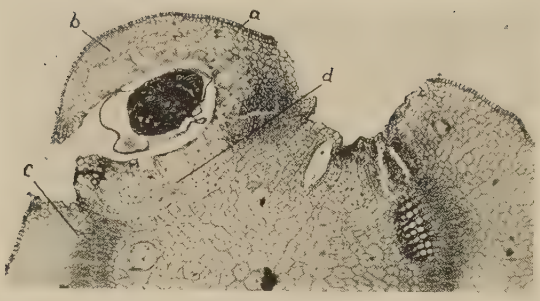

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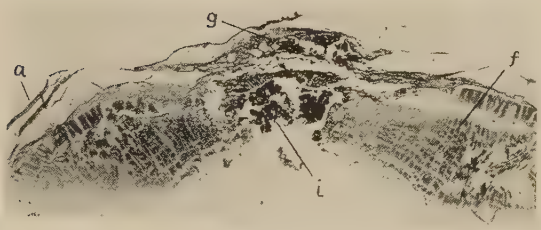

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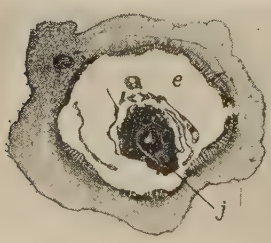

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6

Jute Res. Lab.

EXPLANATION OF PLATE V.

Fig. 1.—Transverse section of stem, showing the position of the egg-deposition; epidermis (*a*); cortex (*b*); phloem (*c*); abnormal tissue-growth (*d*). (×40).

Fig. 2.—Transverse section of stem, showing nature of damage caused by the grub of jute Apion; tunnel (*e*); epidermis (*a*); abnormal cortical cell growth (*g*); periderm (*h*); deformed fibre bundles (*f*). (×8).

Fig. 3.—Transverse section of a 'knotty' fibre; epidermis (*a*); abnormal cortical cell (*g*); refuse matter (*i*); fibre bundles (*f*). (×12).

Fig. 4.—Transverse section of a stem, showing tunnel made by the grub of jute Apion. Pupa (*j*); tunnel (*e*). (×12).

Fig. 5.—Early stages of stem-canker (*k*) caused by species of *Phomopsis*.

Fig. 6.—Advanced stage of stem-canker—cankers coalescing (*l*), epidermis and cortex cracking (*m*).

TABLE XIV.

Effects of fertilizer application

Treatment.	Mean yield per acre lb.	Mean per cent. Stem-rot.	Mean per cent chlorcsis.	Mean height cm.	Mean base diameter cm.	Mean fibre percentage.	Mean Apion attack per cent
nk ca	1538·7	28·4	24·5	145·2	1·30	5·1	44·2
npk ca	1441·4	33·4	19·1	143·4	1·32	4·9	41·5
npk	1205·0	30·2	18·9	140·8	1·38	5·3	41·0
np ca	1200·3	48·1	23·3	128·2	1·40	5·0	53·2
nk	1161·6	44·7	18·9	118·6	1·27	5·1	62·9
np	1148·9	55·1	20·8	118·5	1·36	5·2	59·4
n ca	1083·9	39·6	24·1	118·8	1·25	5·6	50·0
n	1053·3	49·8	12·2	120·9	1·23	5·0	52·6
ca	847·7	39·3	11·5	121·5	1·15	5·3	46·4
pk ca	798·5	25·0	7·4	124·9	1·18	5·1	43·3
pk	777·3	24·0	9·7	133·2	1·23	5·0	41·8
p ca	762·5	49·8	6·7	116·2	1·17	5·2	39·0
k	718·5	22·4	6·2	117·4	1·13	5·3	37·4
k ca	694·3	18·6	5·6	112·5	1·04	5·1	34·7
o	673·9	55·0	9·1	108·6	1·06	5·2	47·8
p	587·8	72·6	4·8	93·2	1·04	5·4	46·6
Critical difference	84·2	23·6	11·4	20·1	0·06	0·6	19·3

Note O=farm yard manure (basal dressing for all treatments) at 100 md. per acre ; n=ammonium sulphate at 6 md. per acre ; p=superphosphate at 3·48 md. per acre ; k=muriate of potash at 1·83 md. per acre ; ca=lime at 9·83 md. per acre.

E. *New diseases on jute.*—

When the crop was in flower or at a capsule bearing stage, 'collar rot' occurred under very humid conditions late in the season. White mycelium grew up on the affected portions and subsequently formed tiny mustard-like sclerotial bodies. The epidermis and cortical tissues were seen to shred and become powdery. The stems broke down at the infected region and died up. From the diseased material *Sclerotium rolfsii* was isolated.

On the Dacca farm black oval necrotic lesions on the stems were seen late in the season. The lesions (Plate V., Figs, 5, 6) were depressed and hard. In some cases these scattered lesions coalesced. The fungus isolated from this material was kindly identified by the Imperial Mycologist, New Delhi, as a species of *Phomopsis*. In retted fibre periderm was seen to persist at these diseased spots.

VIII. PESTS.

A. *Jute Apion—Apion corchori, Marsh.*—

(*i*) *Nature of damage.*—Apion attacks the stem near the apex where vascular bundles are still isolated and the xylem cylinder incomplete. The egg is laid inside the stem by piercing through the epidermis, cortex, starch-sheath, and phloem. The egg is often deposited in the area lying between the two vascular bundles where the cells are very small and thin-walled. Due to the injury, normal cambial activity is checked and abnormal tissue-growths result which separate, protect the vascular bundles, and hinder the development of fibres and xylem (Plate V., Fig. 1). Where the puncture is directly towards the vascular bundles, the differentiating fibre-cells are injured.

The egg hatches in about four days. The grub feeds on the surrounding tissues, ultimately damaging the fibre layers. Prolific growth of abnormal cortical cells lying on the outside of the fibre layers gives the stem a swollen appearance (Plate V., Fig. 2). The grub generally tunnels into the pith and travels up or down the stem for a considerable distance (Plate V., Fig. 4). As the tissues upto the pith are exposed to the outside, all along the passage a very thick layer of periderm is developed to protect the healthy tissues of the bark and wood. From the section it

is evident that normal growth of the phloem and fibre layers close to the injury has been impaired and the fibre bundles are deformed (Plate V., Fig. 2). Mucilaginous and gummy substances accumulate around the wound and cement the refuse matter with the adjoining tissues. On retting, therefore, the tissues such as, the abnormal cortical cells along with the epidermis, periderm associated with the deformed fibre-bundles and intervening pholoem cells, and refuse matter do not dissolve away but form a compact mass. Thus a 'knot' is produced on the fibre (Plate V., Fig. 3).

If the damage is serious, the stem above the damage withers and droops down, encouraging the production of side branches.

(*ii*) *Extent of damage*.—In gauging the damage, percentage of plants attacked as well as the intensity of damage on attacked plants, seem to be important. From table XV it is evident that over fifty per cent. of the *capsularis* plants had been attacked by Apion three times or more. In general, however, larger the number of plants attacked, greater is the intensity of damage. Thirteen commercial samples supplied by the Director, Technological Research Laboratories were examined for Apion damage. 'Reeds' of 100 plants were examined in each sample. The percentage of damaged 'reeds' varied from nine to ninety-one and the intensity of damage from 1·00 to 4·14 punctures per attacked 'reed' (vide table XV.). Apion-attack appears to be wide spread. The extent of damage may best be expressed as average number of punctures per plant irrespective of the fact whether the plant was damaged or healthy.

TABLE XV.

Intensity of Apion attack			Extent of Apion damage in commercial fibre		
No. of punctures by Apion	Frequency of attacked plants. Per cent.		Sample No. of T. R. L.	Attacked 'reeds' per cent.	Average No. of 'knots' in attacked 'reed's.
	Olitorius	Capsularies			
	C. G., R 26 & Local	D 154, D 386 & Fanduk			
0	38·58	16·63	J·93	9	1·11
1	25·09	16·29	J·87	11	1·18
2	19·22	17·19	J·97	13	1·00
3	10·74	19·80	J·91	14	1·50
4	4·37	14·82	J·86	36	1·77
5	1·37	7·92	J·92	41	1·09
6	0·25	3·72	J·94	50	1·64
7	0·12	2·04	J·90	54	1·48
8	0·12	0·68	J·89	60	1·51
9	0·00	0·57	J·95	64	1·73
10	0·00	0·23	J·96	65	1·94
11	0·00	0·00	J·85	67	2·04
12	0·00	0·00	J·88	91	4·14
13	0·00	0·00			
14	0·00	0·11			
15	0·00	0·11			

Fibres obtained from seven quality trials were also examined for Apion damage. *Olitorius* fibre grown at Berhampore, Chinsurah and Pabna showed less attack than that grown at Dacca vide table XVI. Variation in Apion damage from place to place is to be expected. Whether Apion infestation is less in pure *olitorius* tracts is a point which requires further investigation. The insect prefers *capsularis* and it may be that the population of Apion is more where *capsularis* and *olitorius* are both grown as

against pure *olitorius*. At the time of the visit during July at Berhampore and Pabna, Apions were scarcer than at Dacca.

Rangpur fibre recorded the maximum number of 'knots' and the Faridpur one the least in *capsularis*. That 'knots' do not result from all the punctures is evident from the fact that the numbers of punctures observed in the standing crop were consistently higher than the numbers of 'knots' in the corresponding fibre. The percentage of plants attacked corresponds closely to the number of damaged 'reeds'. It is however clear that a fair estimate of the damage can be obtained by the examination of the fibre samples only.

TABLE XVI.

Amount of Apion damage in quality trials.

Fibre from.	Average number of 'knots' per 'reed'		
	C.G.	R. 26	Local
Pabna	0·20	0·27	0·19
Berhampore	0·08	0·11	0·07
Chinsurah	0·13	0·11	0·12
Dacca	0·66	1·00	0·38
In the standing crop Dacca ...	1·09	1·45	1·19
Fibre from.	**D.154**	**D.386**	**Fanduk**
Rangpur	5·13	4·48	4·51
Faridpur	1·55	1·12	0·90
Dacca	1·53	1·77	1·59
In the standing crop Dacca ...	2·45	2·54	2·57

The crop around the borders suffered heavier attacks than the inner one. On an average, in *capsularis* the border-plants had 7·93 punctures per plant as against 2·98 for the inner plant. Corresponding figures for *olitorius* were 1·22 and 1·79 for the inner and outer plants respectively.

After the harvest of jute, from *char* and *beel* lands, the weevils fly to high land areas near villages. They over-winter in shrubs and bushes, and when the jute is sown, they come out

and attack the nearest fields. Farther away from the hibernating centres the attack becomes gradually lighter. Weevils, however, were observed even at a distance of over two miles from their hibernating shelter.

In the manurial experiment in treatments KCa and K, the incidence of attack was significantly lower than in the no manure plot, but this is not in agreement with the previous years' finding (vide table XIV).

Varietal resistance to Apion attack was assessed for all the forty-nine types. No type proved significantly superior to the two standard varieties. Thirteen *capsularis* varieties proved significantly inferior to D.154.

C. acutangularis, *C. trilocularis*, *C. fascicularis*, and *C. olitorius* from Coimbatore, were also susceptible to Apion infestation. *C. acutangularis* which has long hairs on the leaf, petiole and stem was heavily infested.

(*iii*) *Efficiency of parasites in the control of the pest.*— Efficiency of the parasites in parasitizing the immature stages of jute Apion was studied throughout the jute season, vide table XVII below. Parasitization was at its highest in July and August, and it fell off towards the end of September as the crop matured. This may be due to the fact that commencing from the latter part of July, the weevil prefers to lay eggs near the collar region of the stem. Even when young crop is available, the top portion of the stem is rarely infested. Only about fifteen per cent. of the immature stages at the collar region are found to be parasitized as against fifty per cent. in the top portion of the stem.

TABLE XVII.

Efficiency of parasitization.

Month.	No. of immature stages examined from the stem.	Per cent. of imature stages. parasitized.	Proportion of Chalcid to one Braconid parasite.
June ...	447	36·91	0·6
July ...	419	57·51	4·4
August ...	121	57·24	5·6
September ...	469	55·10	2·9
From stubbles—			
September ...	88	14·77	...
October ...	35	17·14	...

In June braconid parasite was more efficient, thereafter chalcid proved more effective. Secondary or alternative hosts for these parasites remain to be located. Specimens of parasites were sent to the Imperial Entomologist, New Delhi, for indentification. The chalcid parasite was found to belong to a new genus of *Miscogasteridae* family. The braconid parasite could not yet be indentified.

B. *Other pests.*—

(*i*) *Jute semilooper,—Cosmophila sabulifera.*—Three main broods of this semi-looper were observed, and of these the second brood did the heaviest damage. A large number of these semi-loopers were collected by the first week of July and sixty-two per cent of them were found to be parasitized by one species of Tachinid fly. The larva of the parasite feeds on the internal tissues of the host. The body-colour of the host changes from green to yellow and finally to yellowish dark. By the time the larva becomes full fed, the semilooper is dead. The larva of the parasite enters the soil for pupation. This parasite has been identified as *Tricholyga sorbilans* Wied.

From a single specimen of parasitized semilooper, over a thousand chalcid parasites were obtained and identified as *Liotomastix* sp. n. (Encyrtidae).

Serious out-breaks of jute semilooper at Dacca, Faridpur, Berhampore and Pabna were effectively controlled by spraying with lead arsenate solution. Addition of one part of nicotine sulphate to 1000 parts of lead arsenate solution enhanced the toxic action.

(*ii*) *Hairy caterpillar—Diacrisia obliqua.*—Incessant rains during the resting period caused heavy mortality of the pest and thus lessened its attack. The proportion of female to male months was lower in June (32·61 per cent females) and higher in July (54·22 per cent females).

Following parasites were bred from the Hairy caterpillars.

1. *Apanteles obliquae* Wilk. (Braconidae).
2. Ichneumonid parasite—not identified.
3. *Eurytoma* sp. (Eurytomidae).
4. Tachinid parasite—not identified.

(*iii*) *Red mites*.—Severe out-breaks of red mites were noticed in many districts of Bengal *viz*., Dacca, Tippera, Mymensingh, Berhampore, Rangpur and Pabna. Both *olitorius* and *capsularis* appeared to be equally susceptible to mite-attack. Mites attack the lower surface of the leaves and suck the juice. The symptoms of mite-attack are (1) curliness of leaves (2) coppery purplish and yellowish discolouration of leaves, (3) partial drying and early fall of leaves, (4) partial or complete stoppage of the plant growth, (5) shortening of the internodes, (6) abrupt reduction in the thickness of the stem, and (7) increase in branching.

All stages from egg to adult were found on the under surface of the leaves. Lime sulphur dusting in the proportion of 3 : 1 was found quite effective in the control of mites. Within three days the crop became free from mites.

(*iv*) *Indigo caterpillar—Laphygma exigua*.—The following parasites were bred from Indigo-caterpillars.

1. *Euplectrus* sp. n. (Eulophidae).
2. Ichneumonid parasite—not identified.
3. Ichneumonid parasite—not identified.

IX. MISCELLANEOUS.

To produce polyploid mutants which may be of economic value, seeds of D.154 and Chinsurah Green were treated with Colchicine prior to sowing. One D.154 plant appears to have responded to colchicine treatments. Its leaves were rough and rounded, flowers bigger than the normal ones. Th capsules were double the normal size (Plate I., Figs. 2, 3) and had only three seeds per loculers.

Observations were made regarding the anthesis of jute.

A series of educative radio talks on jute and insect pests of crops was delivered by the members of the staff, from the All-India Radio Station, Dacca.

X. SUMMARY.

The report covers the second jute season, and besides corroborating the broad conclusions that were drawn last year, records a steady progress towards the solution of manifold agricultural problems.

The relationship between the yeild, and height and diameter of stem was proved to be equally good in other varieties of jute. On the basis of these two characters, 264 fresh selections were made.

Selections made in 1939 were studied and tested; forty-eight *olitorius* and thirty *capsularis* cultures have been deemed worthy of further work. In the second year's trial, twenty-one *capsularis* pure-lines out-yielded the standard variety.

First generation of progenies of crosses were studied. Inheritance of fibre-length, fibre-percentage, diameter of the stem, shape of pod, leaf shape, and pigmentation in the plant, is under investigation. It was observed that while *capsularis* is normally self-fertilized, in *olitorius* there is considerable natural cross-pollination.

From the first year's quality trials, it appears the quality of fibre largely depends upon the conditions of growth of jute plant, as well as conditions under which it is retted. Under ideal conditions of plant-growth and retting, however, certain varieties may give superior fibre.

Causes of colouration in fibre were investigated, and it was found that tannic acid in combination with iron produced colour. The presence of tannins in jute plants and weighing down materials was proved.

Analyses of retting waters were continued. The composition of water appeared to vary according to its acidity. When maximal acidity was reached, total solids, organic matter, and total and permanent soap hardnessesses were also at their maximum. Increased acidity produced during retting, possibly dissolved some of the constituents of suspensions which were originally present in the water and which came also from the steeped jute. Irrespective of the nature of the water, the total hardness increased during retting but the increase in soft waters was mainly due to permanent hardness, whereas in hard waters it was due to temporary hardness.

From the results of analytical work it appears that in future it will suffice if iron, total, permanent and temporary soap hardness, acidity, alkalinity, total solids and organic matter are estimated.

Anatomical investigation of the structural changes that take place during retting of jute stems, proved very interesting and instructive. As a result it became possible to clearly define retting and to understand how and why inferior fibre is produced.

Prior to steeping when the cut-plants are stacked in the field for two to four days, the tissues of the stem shrink; this facilitates on steeping, a rapid entry of water into the stem, the tissues swell, micro-organisms (bacteria and a fungus) invade the stem and contents of the cells are washed out. Micro-organisms break-down the radial walls of cells. First of all, the cambial cells break-down and this effects separation of the bark from the woody cylinder. Dissolution of cortical cells which is preceeded by the break-down of soft phloem cells, isolates the periderm from the stem. With this freeing of fibre strands from other structural elements associated with them, retting is complete.

The retting is completed in different parts of the stem at different times. Structural peculiarities of the top portion of the stem are such that it rets very much more quickly than the bottom. By the time the basal end of the stem gets retted, the fibre-bundles at the top become split into smaller ones on account of over-retting. As thin stems ret quicker than the thick ones, the jute of uniform thickness should give better fibre.

Defective fibre results from the adherance of thick periderm or other undesirable tissues to the fibre. Defects in the fibre appear most frequently at the regions near the nodes, lenticels and places of injury. Bad quality of Dowrah and Chandpur samples was due to incomplete retting.

To investigate the suitability of growing fibre-jute in lines an experiment was conducted. It was difficult to ensure uniform stand. Weeding with wheeled hand-hoes, which can be adopted only when the crop is sown in lines, is very economical. *Olitorius* with stood line-sowings better than the *capsularis*. In line-sowing experiments, which were conducted on seed-jute in Bihar, the spacing between the rows appeared to be more important than the spacing within the row. Wider spacings between the rows did not prove as efficient as the closer spacing of 15″. No definite conclusion could be reached regarding the response of seed-jute to manurial treatments.

From an experiment designed to ascertain the influence of rate of seeding and stage of harvest on the quality of fibre, it was observed that, in general, with a heavier seed-rate the out-turn of fibre was better.

In a manurial experiment, it was observed that manuring with ammonium sulphate at six maunds per acre, enhanced the yield. The best response was obtained when ammonium sulphate was supplemented with lime and muriate of potash. The influence of fertilizers on height and thickness of stem and fibre percentage was noticeable. Chlorosis did not seem to affect the yield materially, but the stem-rot reduced the yield appreciably. Applications of potash alone, or in combination with lime or phosphate helped to check the infection of stem-rot.

The development and progress of symptoms of stem-rot were observed and correlated with climatic conditions. A severe epidemic of stem-rot was noticed near Narsingdi in Dacca district. The anxiety of the cultivators in that area was best expresssed in their statement that "the jute was forsaking the land".

Susceptibility of all the forty-nine types of jute to stem-rot was determined. Certain types have been earmarked for intensive selection with a view to obtain resistant strains. No variety proved immune to stem-rot. Tosha (*olitorius*) proved again more resistant than White (*capsularis*) jute.

To destroy the infection borne on and within the seed, hot-water treatments of seeds were carried out. With higher temperatures, shorter treatments, and with lower temperatures, longer treatments were necessary. Complete disinfection of seed could be obtained only at the sacrifice of germination. A reasonable reduction in infection, with a germination of at least 80 per cent. could be obtained by treating the seeds in hot water either at 58° for seven minutes, 57° for ten minutes, or 56°C for twenty minutes.

The development and progress of chlorosis were observed. Partial recovery was noticed in some plants, but definite instances of complete recovery were rare. The disease could be transmitted by grafting. Chlorosis was very rare in Tosha varieties. Two unrecorded diseases caused by *Sclerotium rolfsii* and a species of *Phomopsis* were met with at Dacca.

By examining the sections of apion-attacked stems, the nature of damage to various tissues of the stem, and the mode of formation of the 'knot' in the fibre were studied. Field investigations on Apion-damage revealed that in reckoning the amount of damage, the percentage of plants attacked, as well as the intensity of damage should be considered. The total damage may best be expressed as number of punctures or 'knots' per plant or 'reed' depending upon whether the observation was made on the plant or on the fibre. A fair estimate of the damage on the crop, can be obtained by examining the fibre only.

The border crop was seen to suffer heavier attacks. Farther away from the hibernating shelters, the attack became gradually lighter. The resistance of varieties to Apion attack was assessed.

A study of the efficiency of parasites in controlling the Apion revealed that parasitization fell off as the crop matured. On the whole, the chalcid parasite proved more efficient than the braconid one.

Two parasites of jute-semilooper, four of hairy-caterpillar and three of indigo-caterpillar were bred. A majority of them were new species.

Severe out-breaks of red-mites on jute were observed in many districts of Bengal. The symptoms caused by this pest which appears to be an unrecorded one on jute, were studied. Dusting with lime-sulphur proved quite effective in the control of mites.

J. S. PATEL,

Director,

Jute Research Laboratories,

Indian Central Jute Committee.

DACCA, *dated 1st May, 1941.*

ENCLOSURE I.

Analyses of retting waters in ppm.

N = Natural water, C = Candled water, S = Suspensions in water.

Place from where collected	Date of drawing samples	Fe	Ca		Mg		K	Total solids		Hardness computed		Soap hardness: Total		Permanent		Temporary		Phenolphthalene acidity		Me-Red alkalinity		Total organic matter		
		N	N	C	N	C	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C	N	C	S
Dacca tank	24-8-40	2·94	6·10	2·71	2·29	1·70	3·37	128·0	43·0	24·6	13·8	7·9	7·9	8·7	8·7	−0·8	−0·8	4·0	2·5	16·0	16·0	4·7	3·4	1·3
Do.	31-8-40	3·98	5·99	5·60	2·95	2·86	9·06	143·0	72·0	26·2	25·7	24·7	24·7	22 1	22·1	2·6	2 6	7·0	5·0	22·0	25·0	12·4	8·6	3·8
Do.	7-9-40	2·31	3·92	4·35	1·64	1·73	3·81	153·0	39·0	17·2	18·0	14·3	16·9	14 3	16·3	0·0	0·6	3·0	2·0	16·5	17·0	7·0	4·0	3·0
Do.	14-9-40	2·19	3·75	3·53	1·73	1·51	2·85	97·0	38·0	16·5	15·0	14·3	18·2	12·7	18·2	1·6	0·0	9·5	4·5	22·0	19·0	5·7	3·7	2·0
Do.	21-9-40	5·25	8·45	...	3 27	...	...	149·0	106·0	34·5	...	31·2	35·8	24·7	36·4	6·5	−0·6	9·5	4·5	35·0	34·0	26·6	10·4	16·2
Do.	28-9-40	4·04	4·44	...	2·01	...	...	172·0	61·0	19·3	...	14·3	18·9	14·3	18·2	0·0	0·6	4·0	3·5	17·5	27·0	11·6	5·7	5·9
Do.	5-10-40	5·14	14·87	...	4·19	...	...	233·0	176·0	54·4	...	68·6	57·1	57·1	65·7	11·5	−8·6	24·0	12·5	12·0	15·0	29·8	15·4	14·4
Do.	12-10-40	4·21	11·50	...	3·25	...	...	190·0	100·0	42·1	...	41·6	39·0	35·1	33·8	6·5	5·2	14·5	5·0	40·0	39·0	25·4	10·6	14·8
Do.	19-10-40	5·95	13·87	...	3·80	...	...	153·0	98·0	50·3	...	38·4	40·3	33·8	26·7	4·6	13·6	9·0	5·0	59·0	53·0	27·6	13·6	14·0
Do.	26-10-40	3·00	5·77	...	1·86	...	...	108·0	64·0	22·1	...	55·7	50·0	39 0	42·9	16 7	7·1	4·5	3·5	23·0	30·0	14·4	12·4	2·0
Mean	...	3·90	7·87	4·05	2·7	1·95	4·77	152·6	79·7	30·7	18·1	31·1	30·9	26·2	28·9	4·9	2·0	8·9	4·8	26·3	27·5	16·5	8·8	7·7
Faridpur tank	1-9-40	0·75	27·2	25·49	10·37	10·57	...	298·0	238·0	110·1	106·3	...	85·7	26·6	51·4	...	34·3	12·0	3·0	108·0	94·0	...	...	...
Do.	8-9-40	2-71	68·57	67·29	25·66	25·88	44·19	559·0	419·0	276·6	274·3	251·2	239·0	28·6	29 9	222·6	209·1	8·5	1·0	299·5	289·5	...	...	...
Do.	13-9-40	1·91	76·98	74 43	24·13	24·02	28·28	447·0	373·0	291·4	284 6	248·2	239·0	20·8	16·9	227·4	222·1	16·5	15·5	310·0	292·5	...	...	...
Do.	23-9-40	0·87	74·94	73·41	25·33	25·23	32·82	452·0	400·0	291·2	287·0	251·2	254·2	20·8	16·9	230·4	237·3	6·0	5·0	329·0	322·0	...	...	...
Mean	...	1·56	61·88	60·16	21·27	21·37	35·10	439·0	357·5	242 3	238·0	250·2	244·1	23·4	21·2	226·8	222·9	10·75	6·13	261·6	249·5	...	...	...
Chinsurah Pit 1	5-10-40	0·64	28·96	28·75	7·88	7·64	2·57	135·0	100·0	104·7	103·2	84·3	84·3	28·6	29·9	55·7	54·4	6·5	3·0	111·0	106·0	...	...	...
Do. do. 2	7-10-40	0·81	34·77	33·65	8·63	8·56	3·64	175·0	169·0	122·3	119·2	97·1	97·1	18·2	15·6	78·9	81·5	3·0	2 0	136·0	133·0	...	...	...
Mean	...	0·73	31·87	31·20	8·26	8·10	3·11	155·0	134·5	113·5	111·2	90·7	90·7	23·4	22·8	67·3	67·9	4·8	2·5	123·5	119·5	...	...	...
Rangpur	11-9-40	1·21	5·27	5·27	2·38	2·21	3·02	60·0	51·0	22·9	22·2	16 3	16·9	15·6	15·6	0·7	1·3	4·0	2·5	3·0	3·5	...	...	...
Berhampore	18-9-40	0·52	27·02	26·77	5·55	5·64	5·14	131·0	120 0	90·3	90·1	74·3	75·7	24·7	29·9	49 6	45·8	−2·0	−2·5	89·0	90·0	...	...	...
Pabna	26-9-40	1 44	44 23	43·84	6·49	6·77	14·99	194·0	188·0	137·2	137·4	110·5	112·0	27·3	26·0	83·2	86·0	8·0	4·5	143·0	144·0	...	...	...
Narayanganj	30-9-40	0·87	10 34	10·09	3·36	3·08	4·15	91·0	61·0	39·6	37·9	29·9	32·5	27·3	29·9	2·6	2·6	1·5	3·0	37·5	36·0	3·6	3·1	0·5
Parchimdamadardi near Narayanganj ...	30-9-40	0·46	6·32	6 27	2·18	2·16	2 29	41·0	37·0	24·7	24·5	20·8	20·2	22·1	21·5	−1·3	−1·3	2·5	2·5	24·0	25·0	3·9	3·0	0·9
Ekrampur Beel near Narayanganj	29-9-40	0·43	6·27	6·53	2·34	2·36	1·95	33·0	27 0	25·3	26·0	21·5	22·1	19·5	20·2	2·0	1·9	2·0	2·0	25·5	25·0	4·0	3·4	0·6
Lakha River near village Kowadi	18-8-40	2·45	10·06	9·87	3·47	3·12	4·46*	121·0	...	41·9	37·5	32·5	31·2	34·5	27·3	−2·0	3·9	3·0	...	35·0	...	4·8	3·6	1·2
Banar river near Barama ...	18-8-40	1·62	10·30	10·17	3·23	2·97	3·70*	89·0	58·0	39·0	37·6	29·9	31·2	34·5	27·3	−4·6	3·9	4·0	0·5	36·0	35·5	4·6	3·8	0·8
Brahmaputra Mymensingh ...	20-8-40	0·75	11·57	11·57	4·19	3·10	5·05*	86·0	59·0	46·1	41·6	33·8	33·8	32·5	29·9	1·3	3·9	5·0	0·5	39·0	39·0	4·0	2·8	1·2
Titash river Tipperah ...	22-8-40	0·52	4·89	5·36	4·52	2·14	2·46*	51·0	45·5	30·8	22·2	16·9	18·2	19·5	16·9	−2·6	1·3	4·0	1·0	20·5	22·0	7·5	4·6	2·9
Moutar Ghat near Narayanganj	6-10-40	4·39	12·34	13 46	3·21	3·60	3·75	330·0	56 0	44·0	48·4	52·2	37·7	32·5	33·8	19·7	3·9	2·0	4·0	47·0	39·5	4·7	2·7	2·0
Irdar Char	7-10-40	0·17	16·21	15·50	3·41	4·48	3·39	78·0	69 0	54·5	57·1	59·0	47·1	27·3	29·9	22·7	17·2	3·0	1·5	49·0	44·5	3·2	3·0	0·2

*On Natural Water

ENCLOSURE II

Records for 1939 quality trials

Varity	Grown at	Retted	Average quality ratio	Average weight C. V. per cent	Duration of retting days	Average maximum temp. during retting F°	Average minimum temp. during retting F°	Total rainfall during retting inches	No. of rainy days during retting	Date of steeping	Date of sowing	Date of harvest	Interval between sowing cuttting	No. of plants per acre	Total rainfall between sowing and flowering	No. of rainy days between sowing and flowering	Total rainfall between sowing and cutting	No. of rainy days between sowing and cutting	Average temperature between sowing and cutting. Maximum F°	Average temperature between sowing and cutting. Minimum F°
D. 154 ...	Faridpur ...	Faridpur ...	83·3	25·8	16	93·6	76·4	5·78	4	18/9	9/5	15/9	129	146,767	53·77	60	58·36	66	90·3	75·8
	Faridpur ...	Dacca ...	84·4*	23·9*	16	88·8	78·1	6·62	7	19/9	9/5	15/9	129	146,767	53·77	60	58·36	66	90·3	75·8
	Rangpur ...	Rangpur ...	70·7	28·7	28	84·7	78·2	17·02	11	20/9	28/3	17/9	181	65,772	49·11	52	58·47	74	87·5	80·2
	Rangpur ...	Dacca ...	83·1*	25·9*	15	88·6	77·8	6·62	7	20/9	28/3	17/9	181	65,772	49·11	52	58·47	74	87·5	80·2
	Dacca ...	Dacca ...	67·7	28·4	16	89·5	78·4	3·67	6	16/9	11/5	13/9	125	108,415	59·68	61	63·99	70	85·6	77·8
D. 380 ...	Faridpur ...	Faridpur ...	79·0	25·2	19	95·5	75·4	10·38	8	25/9	9/5	21/9	135	145,886	53·77	60	60·01	68	90·5	75·9
	Faridpur ...	Dacca ...	101·2*	26·4*	18	88·4	76·9	10·70	9	24/9	9/5	21/9	135	145,886	53·77	60	60·01	68	90·5	75·9
	Dacca ...	Dacca ...	74·2	30·6	15	89·3	78·4	4·02	7	15/9	11/5	12/9	124	104,866	60·38	63	62·47	66	85·6	77·8
	Rangpur ...	Rangpur ...	73·3	29·5	29	84·0	78·0	17·74	11	27/9	28/3	24/9	192	70,276	54·27	58	58·96	76	87·5	80·2
	Rangpur ...	Dacca ...	82·2*	26·1*	16	88·4	76·7	8·84	7	27/9	28/3	24/9	192	70,276	54·27	58	58·96	76	87·5	80·2
Fanduk ...	Faridpur ...	Faridpur ...	86·6	25·0	18	90·8	76·7	3·42	6	9/9	9/5	5/9	119	148,323	27·80	42	56·88	62	90·4	75·7
	Faridpur ...	Dacca ...	103·6*	22·5*	12	88·9	78·4	2·98	8	9/9	9/5	5/9	119	148,323	27·80	42	56·88	62	90·4	75·7
	Dacca ...	Dacca ...	76·8	29·4	13	91·5	79·9	2·91	5	28/8	11/5	25/8	106	102,938	23·79	35	59·68	61	84·6	77·5
	Rangpur ...	Rangpur ...	73·4	28·1	29	85·2	78·7	17·99	13	14/9	28/3	11/9	167	76,465	41·05	42	55·98	68	87·6	80·2
	Rangpur ...	Dacca ...	90·3*	28·8*	13	89·2	78·4	3·69	7	14/9	28/3	11/9	167	76,465	41·05	42	55·98	68	87·6	80·2
R. 26 ...	Rajshahi ...	Rajshahi ...	113·8*	24·1*	20	94·4	78·9	8·34	10	6/10	14/6	3/10	111	149,745	39·65	51	50·42	66	93·4	79·0
	Rajshahi ...	Dacca ...	104·8*(a)	27·2*(a)	17	89·7	74·7	6·21	5	7/10	14/6	3/10	111	149,745	39·65	51	50·42	66	93·4	79·0
	Dacca ...	Dacca ...	109·6	22·5	11	89·4	78·6	2·79	4	21/9	9/5	18/9	132	114,610	59·52	60	65·34	74	85·6	77·7
	Chinsurah ...	Chinsurah ...	105·3	22·2	17	90·0	80·2	6·50	7	19/9	16/5	16/9	123	84,095	49·10	64	60·38	82	91·0	80·9
	Chinsurah ...	Dacca ...	107·8*	26·4*	11	89·4	79·0	2·79	4	19/9	16/5	16/9	123	84,095	49·10	64	60·38	82	91·0	80·9
Chinsurah Green ...	Rajshahi ...	Rajshahi ...	113·7*	23·1*	19	96·0	76·8	9·25	9	25/9	14/6	22/9	100	147,186	39·14	49	48·63	62	93·1	79·1
	Rajshahi ...	Dacca ...	102·4*(a)	21·8*(a)	18	88·4	76·9	10·70	9	24/9	14/6	22/9	100	147,186	39·14	49	48·63	62	93·1	79·1
	Chinsurah ...	Chinsurah ...	105·3	21·3	17	90·5	80·7	5·94	7	14/9	16/5	11/9	118	86,403	44·68	58	51·66	71	91·3	80·9
	Chinsurah ...	Dacca ...	93·7*	22·3*	12	89·3	78·3	3·58	6	14/9	16/5	11/9	118	86,403	44·68	58	51·66	71	91·3	80·9
	Dacca ...	Dacca ...	103·4	21·7	14	89·3	78·6	3·17	4	17/9	9/5	14/9	128	114,060	59·52	60	64·29	73	85·5	77·7
Local ...	Rajshahi ...	Rajshahi ...	114·7*	21·7*	18	95·0	76·8	10·57	10	23/9	14/6	19/9	97	158,940	37·34	42	44·35	52	92·9	79·0
	Rajshahi ...	Dacca ...	107·0* (a)	25·7*(a)	19	88·3	76·5	10·70	9	23/9	14/6	19/9	97	158,940	37·34	42	44·35	52	92·9	79·0
	Dacca ...	Dacca ...	107·1	21·3	14	89·3	78·5	3·17	5	16/9	9/5	13/9	127	118,975	58·43	57	65·34	74	85·5	77·7
	Chinsurah ...	Chinsurah ...	103·5	20·3	17	90·4	80·6	6·24	7	16/9	16/5	13/9	120	85,525	46·02	61	56·67	76	91·1	80·8
	Chinsurah ...	Dacca ...	97·6*	21·3*	11	89·5	78·6	3·14	5	16/9	16/5	13/9	120	85,525	46·02	61	56·67	76	91·1	80·8

(a) As the sample was short, a small quantity of similar fibre was added before the test, but this did not have appreciable effect on the result.

* Single values.

Programme of work as sanctioned (1)	Progress made. (2)	Nature of future work. (3)
Collection of varieties and types.	Five wild species of jute were added to the collection. Forty-eight district samples of seeds were collected and studied.	As in col. 1
Selections in *capsularis* and *olitorious*.	Trials of selections were continued. Fresh selections were also made. Criterion for selection were studied, and correlations worked out.	Testing of the selections ; fresh selections to be made ; a study of the efficiency of criterion of selection as proved by breeding tests.
Hybridization—Varietal and interspecific.	F_1s of programmed varietal crosses were raised and studied. Interspecific hybridization was attempted without apparent success.	Study of the progenies of varietal crosses with a view to selection in later generations. Further attempts at interspecific crosses.
Inheritance of characters viz, chlorosis and length of fibre.	Chlorotic and non-chlorotic parents have been islolated for crossing. For studying the inheritance of length of fibre, variant character of leaf, colour in the plant, and shape of pod F_1s were grown. Chlorosis was transmitted by grafting.	Study of further generations of crosses accompained by back-crossing. Study of the inheritance of base-diameter and fibre percentage.
Effects of varieties growth conditions and different kinds of retting waters on quality.	Experiments with D·154 D 386, and Fanduk were carried out at Dacca, Rangpur and Faridpur. Experiments with Chinsurah Green, R. 26, and locals were conducted at Dacca, Chinsurah, Berhampore and Pabna. Fibre was sent for necessary technological tests. 1939 tests show that influence of conditions of growth and retting waters is most important.	As in col. 2
Survey of prevalent retting methods and conditions in Bengal.	This could not be done for want of funds under Travelling allowance.	As in col 1

Programme of work as sanctioned. (1)	Progress made. (2)	Nature of future work. (3)
Analyses of retting waters.	Chemical analyses of retting waters from Dacca, Rangpur, Chinsurah, Berhampore, Pabna, Faridpur stations and nine other centres were carried out. Bacteriological examination could not be undertaken in the absence of a trained assistant to do this work.	As in col. 2
Infiuence of flooding on bark and root formation.	This investigation was completed in 1939 and has been dropped.	Nil.
Development of roots in Dowrah and Tippera jutes.	Anatomical examination of Dowrah and Chandpur samples showed that the fibre was extracted before the retting had completed.	Examination of more defective samples.
Formation of the fibre.	Anatomical examination of the development and formation of fibre in D. 154 and Chinsurah Green was studied, stage by stage.	A comparative anatomical study of different varieties of jute.
A study of the changes in the structure of the stem during retting. (New item)	A periodical examination of the retted stems was carried out and the changes that occur during retting were observed.	No further work is necessary.
Influence of seed-rate, stage of harvest and retting period on quality.	This experiment was carried out and fibres sent for technological tests. In general with a heavier seed rate, the out-turn of fibre was better.	As in col. 2
Line sowing of fibre-jute.	An experiment was conducted to test the possibility of growing fibre-jute in lines. It was found difficult to ensure uniform germination.	Experiment to be continued.
Spacing and manurial experiment on seed-jute.	Experiments were conducted at Pusa and Sabour. Spacing between the rows appeared to be more important than the spacing with in the row. No definite conclusion could be reached regarding the influence of manurial treatments on seed-jute.	Experiment to be continued.

Programme of work as sanctioned.	Progress made.	Nature of future work.
(1)	(2)	(3)
Macrophomina disease (a) Intensive study of the fungus.	Intensive study of this fungus as it occurs in jute fields in Bengal could not be undertaken for want of adequate travelling allowance and assistant.	To be carried out if extra facilities are provided as under col. 2
(b) Physiological races.	Mode of spread of disease, and its transmission through seed were studied. To disinfect the seeds various means were tried. Races of this fungus have been isolated, and collected from different stations in India.	To be continued as under col. 2. Relative pathogenicity of the races to be studied.
(c) The study of effect of climatic and environmental conditions on the incidence of disease.	Effects of ecological conditions on the incidence of disease have been studied at Dacca.	This needs to be extended to other jute growing districts.
(d) Varietal-resistance.	Relative resistance of different varieties to this fungus has been assessed.	This should be continued for another year. Thereafter only fresh material need be tested for resistance.
(e) Black band disease Varietal resistance.	As the disease appeared sporadically, varietal resistance could not be accurately estimated.	As under col. 1
Effect of manures on the incidence of disease.	Sixteen manurial treatments were tried out. Applications of potash alone, or in combination with lime or phosphate helped to check the infection of stem-rot.	Experiment to be continued.
Jute-Apion	The nature and extent of damage caused by Jute-Apion were studied. Its mode of hibernation confirmed. The chalcid parasite proved more efficient than braconid one.	A survey of the damage in relation to ecological factors. This can be undertaken if extra assistant is provided. Effect of destruction of hibernating shelters should be investigated. Life-history of parasites to be studied.

Programme of work as sanctioned. (1)	Progress made. (2)	Nature of future work. (3)
Other insect pests : Incidence of pests in relation to ecological factors, damage done, and control measures.	The incidence of, and damage done by jute-semilooper, hairy-caterpillar, and indigo-caterpillar were studied. The appearance and spread of pests were correlated with the climatic conditions. Effective control measures have been devised for jute-semilooper and hairy-caterpillars. Certain parasites were bred.	The appearance and spread of these pests in other jute growing areas need to be studied. Control measures for indigo-cater-pillar. Efficiency of parasites in control of pests.
Crop-cutting expe-rements.	Discontinued after 1939.	

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